1913

Transcript of Record, Volume II: The Wright Company vs. The Herring-Curtiss Company and Glenn H. Curtiss

United States Circuit Court of Appeals, Second Circuit

United States Circuit Court of Appeals

FOR THE SECOND CIRCUIT

THE WRIGHT COMPANY
Complainant-Appellee

vs.

THE HERRING-CURTISS COMPANY AND GLENN H. CURTISS
Defendants-Appellants

TRANSCRIPT OF RECORD

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES
FOR THE WESTERN DISTRICT OF NEW YORK

Vol. II

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Vol. I.—Pages 1 to 955.
Vol. II.—Pages 956 to 1568.
Vol. III.—Pages 1569 to 2184.

INDEX.

COMPLAINANT'S EXHIBITS.

Vol. II.

DEFENDANT'S TESTIMONY.

Defendant's Exhibits.

STIPULATIONS AND AGREEMENTS.

1

United States Circuit Court,

WESTERN DISTRICT OF NEW YORK.

ORVILLE WRIGHT and WILBUR WRIGHT

vs. — In Equity, No. 400.

HERRING-CURTISS COMPANY and GLENN H. CURTISS.

2

Answer.

To the Honorable the Judges of the United States Circuit Court for the Western District of New York.

These defendants, Herring-Curtiss Company and Glenn H. Curtiss, now and at all times hereafter, saving to themselves all and all manner of benefit or advantage of objection or otherwise that can or may be had or taken to the many errors, uncertainties and imperfections in the Bill of Complaint contained, for answer thereto, or to 3
so much thereof as they are advised is material or necessary for them to make answer to, answering, say:

(1) They admit that the Herring-Curtiss Company is a corporation organized and existing under the laws of the State of New York, and has its principal place of business at Hammondsport, New York, and that Glenn H. Curtiss is a resident of said Hammondsport.

(2) These defendants answering on informa-

4 tion and belief, deny that the complainants were ever the true, original, first or joint inventors of any new and useful improvements in flying machines which were not known or used by others in this country before their invention or discovery thereof, deny that they were not patented or described in any printed publication in this or any foreign country before any invention or discovery thereof by them, or more than two years prior to their application for Letters Patent thereon, denies that they were not in public use or on sale in this country for more than two years prior to such application, and were not abandoned
5 and not patented in any foreign country more than twelve months prior to the filing of their said application in the United States.

(3) These defendants are not informed, save by the Bill of Complaint, that the complainants made application for the grant of Letters Patent thereon in accordance with the existing acts of Congress in such cases made and provided, and therefore leave complainants to make such proof thereof as they may be advised is proper. Said defendants are informed and believe that on the 22d day of May, 1906, Letters Patent No. 821,393,
6 were issued to the complainants herein, but upon information and belief deny that said Letters Patent were lawfully issued, or that said Letters Patent did lawfully give or grant to said complainants the full and exclusive, or any, right or liberty to make, use or sell the alleged inventions purported to be covered thereby.

(4) These defendants are not informed, save by said Bill of Complaint, that the alleged invention set forth in said Letters Patent No. 821,393 is of any value or utility, and they specifically

deny that it constituted the first instance in the history of the art to produce a flying machine wherein a heavier-than-air machine ever made ærial flights, or wherein the machine was under the control or will of the operator, and they deny that said alleged invention gave to the world the first machine to actually and successfully fly, or was in this sense the creation or embodiment of a new art or an epoch in ærial endeavor, as man-carrying heavier-than-air flying machines had been, long prior to said Letters Patent and the date of invention of the apparatus set forth therein, made and used and successfully 7
flown. These defendants further deny the con- 8
clusion of law that the United States Government has acquiesced and acknowledged in the validity of said Letters Patent, or recognized any rights of the complainants in and under the same, either by the act of purchasing one of the complainants' flying machines with the right to use the same, or otherwise, or that any one else has acquiesced in or recognized the novelty and utility of the complainants' flying machine and the complainants' alleged rights in and to said Letters Patent. Said defendants are not informed, save
by said Bill of Complaint, whether any of the 9
complainants' machines have been purchased, and therefore deny the same and leave complainants to make such proof thereof as they may be advised is proper.

(5) These defendants are not informed, save by said Bill of Complaint, that the complainants have expended large or any sums of money, or have been to any trouble or expense in or about the development, production or promotion of said alleged invention in flying machines, or any public exhibition, or for the purpose of carrying on the manufacture and sale of said machines, or that

10 such machines are made in accordance with the
alleged invention covered in and by said Letters
Patent, and therefore deny the same and leave
complainants to make such proof thereof as they
may be advised is proper.

(6) Defendants deny that, well knowing the
promises and the rights secured or alleged to be
secured to the complainants, or that contriving
to injure them, or to deprive them of any just
benefits, emoluments or rewards which might or
otherwise would have accrued to them from said
Letters Patent, or the invention covered thereby,
11 they did jointly or otherwise, prior to the commencement of this suit and subsequent to the
date of the Letters Patent, in infringement of such
Letters Patent within the jurisdiction of this
Court, or elsewhere, unlawfully, wrongfully or
willfully, make or have made, assemble, use or
cause to be used, exhibit or cause to be exhibited,
any flying machine embodying or containing any
invention covered in or by the Letters Patent
in suit; and deny that the defendants are preparing to infringe any right of the complainants
secured by said Letters Patent, or otherwise, or
that any act done, threatened or contemplated
12 by the defendants, or any of them, has or will
result in any unlawful loss or injury to the complainant, or has or will unlawfully deprive them
of any sum or profit which they would otherwise
make; and deny that the defendants have infringed said Letters Patent; those defendants
admit that the Herring-Curtiss Company did
manufacture and sell a flying machine to the
Aeronautic Society of New York and delivered
the same to it, and that Glenn H. Curtiss did
conduct exhibition flights with the same, but not
for pay charged for admission or tickets purchased
by the general public, or that large sums of

money have been received by the defendants for 13
such manufacture and sale, or that any loss or injury was unlawfully caused to the complainants herein, and they deny that such machine was or is an infringement of the Letters Patent in suit, and deny that the defendants threaten or intend to continue, or to do any act of infringement.

(7) These defendants deny that unless they, or either of them, are restrained from further making and using such flying machines, or from conducting such flight exhibitions, they will unlawfully destroy any source of revenue which the
complainants would otherwise receive from the 14
alleged invention and Letters Patent in suit, and they say that any acts alleged in Paragraph 5 of the Bill of Complaint were lawful and not cause for action by the complainants herein.

(8) These defendants deny that the complainants have been, or are about to be, unlawfully injured by any acts of the defendants herein, or any of them.

(9) These defendants deny that they were duly notified that any act done or contemplated by
them would infringe said complainants' rights 15
under the Letters Patent, or that they, or either of them, disregarded any notice, but, on the contrary, they allege that any acts done, threatened or contemplated by them were and would be lawful and without any infringement of said Letters Patent in suit.

(10) Said defendants, further answering upon information and belief, deny that they, or either of them, have infringed or are now infringing said Letters Patent in suit, and specifically deny that they, or either of them, intend or threaten to

16 infringe the same, and they deny each and every act of infringement or other unlawful act by them or either of them, contained in the Bill of Complaint.

(11) These defendants, further answering upon information and belief, allege that said Letters Patent #821,393, and each of the claims thereof, is void and of no force and effect, because the alleged inventions and improvements claimed therein and purported to be covered thereby, and every substantial and material part thereof were, prior to any invention or discovery thereof by the
17 complainants herein, or more than two years prior to any application by them for a patent therefor, patented or described in the following patents and printed publications:

U. S. Patents.

97,100, Marriott, Nov. 23, 1869.
291,990. Davis, Jan. 15, 1884.
429,373, Bechtel, June 3, 1890.
582,757, Mouillard, May 18, 1897.
659,264, Stanley, Oct. 9, 1900.
722,516, Johnston, Mar. 10. 1903.

British Patents.

18 1,066 of 1901.
13,700 " 1898.
27,027 " 1902.
473 " 1867.
1,469 " 1870 to Harte.
392 " 1868 to Boulton.
20,435 " 1890.

German Patents.

84,417, 129,146, 134,728, 100,398.

French Patent.

316,970.

American Engineer and Railroad Journal for 19
August, 1894, published by M. U. Fourey, at 47 Cedar Street, New York City, pages 147 etc.; same publication, issue of January, 1895, pages 50 and 51; same publication, issue of June, 1893; "a printed publication entitled 'Revue de L'Aeronautique Theorique et Appliquee,' published by G. Masson, Boulevard Saint-Germain, 120, Paris, France in 1893, pages 70-83, and Plates XII, XIII and XIV." And in other patents and printed publications at present unknown to these defendants, proper allegations of which they pray leave to insert herein when ascertained.

(12) And these defendants further answering 20
upon information and belief, allege that said Letters Patent #821,393, and each of the claims thereof, is void and of no force and effect, because the alleged inventions and improvements claimed therein and purported to be covered thereby were, prior to any invention thereof by said complainants, known to or used by the following named persons within the United States:

Augustus M. Herring of and at New York, N. Y.; Dr. A. S. Mott of and at Coatesville, Va.; Octave Chanute of and at Chicago, Ill.; A. F. Zahm
of and at Washington, D. C.; Hugo Mattullath of 21
and at New York, N. Y.; John J. Montgomery of and at Santa Clara, Cal.; E. P. Johnston of and at Arapahoe, Colorado; Carl Dienstbach of and at St. Louis, Missouri, and New York City; and by the applicants for the foregoing United States patents at the places therein mentioned, and by all said persons elsewhere within the United States, and to and by other persons whose names and addresses are at present unknown to these defendants, proper allegations of

22 which prior knowledge and use these defendants pray leave to insert herein when ascertained.

(13) And these defendants further answering on information and belief, allege that said Letters Patent #821,393, and each of the claims thereof, is void and of no force and effect, because each and every alleged invention or improvement claimed therein was in public use or on sale in the United States for more than two years prior to any application for said Letters Patent.

(14) And these defendants further answering on information and belief, allege that said Letters
23 Patent #821,393, and each of the claims thereof, is void and of no force and effect, because from the state of the art as known at the time of, and long prior to, any invention or discovery by the complainants of any invention claimed therein, said invention or discovery involved nothing more than the exercise of mere mechanical skill and was not patentably novel.

(15) These defendants further answering on information and belief, deny that any invention covered or claimed in said Letters Patent in suit was the joint invention of the complainants; and
24 these defendants further answering on information and belief, allege that the complainants unreasonably delayed to enter a disclaimer of the parts of their invention which have been claimed without right.

(16) And these defendants further answering upon information and belief, deny each and every unlawful act of which they, or either of them, are charged by the Bill of Complaint, and they allege that the complainants have no right to any further answer to said Bill of Complaint, or to any part thereof than is herein contained, and are not entitled to any judgment, account, damage or other

relief prayed for in said bill; without this than any 25
other matter, cause or thing in said complainants' Bill of Complaint contained, material or necessary to be answered by these defendants, and not herein and hereby sufficiently and well answered unto, confessed, avoided, traversed or denied, is true; all of which matters and things these defendants are willing to aver, maintain and prove as this Honorable Court shall direct, and they humbly pray to be hence dismissed with their reasonable costs and charges in this behalf most wrongfully sustained.

GLENN H. CURTISS,
HERRING-CURTISS COMPANY,
By AUGUSTUS M. HERRING, 26
Vice-President.

EMERSON R. NEWELL,
Solicitor & Counsel for Defendants,
#2 Rector Street,
New York City,
New York.

THOMAS A. HILL,
Of Counsel.

State of New York, }
County of New York, } ss.:

Augustus M. Herring, having been duly sworn, 27
deposes and says that he is the Vice-President of the Herring-Curtiss Company, one of the defendants herein; that he has read the foregoing answer and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters stated on information and belief, and as to the matters admitted, and as to such matters he believes it to be true.

AUGUSTUS M. HERRING.

Subscribed and sworn to before me }
this 29th day of Oct., 1909. }

Beatrice Urinah,
[SEAL.] Notary Public.

28 State of New York, } ss.:
County of Steuben, }

Glenn H. Curtiss, having been duly sworn, deposes and says, that he is one of the defendants named in the above entitled case; that he has read the foregoing answer and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters stated or alleged on information and belief, and the matters admitted, and as to such matters he believes it to be true.

GLENN H. CURTISS.

Subscribed and sworn to before me }
29 this 25th day of Oct., 1909. }

W. W. Brumdage,
[SEAL.] Notary Public.

30

UNITED STATES CIRCUIT COURT, 31

WESTERN DISTRICT OF NEW YORK.

THE WRIGHT COMPANY *vs.* HERRING-CURTISS COMPANY and GLENN H. CURTISS.	In Equity No. 400.

Answer to Supplemental Bill.

To the Honorable the Judges of the United States Circuit Court for the Western District of New York. 32

These defendants, Herring-Curtiss Company and Glenn H. Curtiss, now and at all times hereafter saving to themselves all and all manner of benefit or advantage, of objection or otherwise that can or may be had or taken to the many errors, uncertainties and imperfections in the supplemental bill contained, for answer thereto, or to so much thereof as they are advised is material or necessary for them to make answer to, answering, say:

(1) They are not informed whether or not Orville Wright and Wilbur Wright were at any time 33
vested with the title to Letters Patent 821,393, and therefore leave complainant to make proof of the same; they admit that on or about August 20, 1909, said Orville and Wilbur Wright filed a bill in equity in this Court against the Herring-Curtiss Company and Glenn H. Curtiss, in equity #400, wherein they charged said defendants with joint infringement of said Letters Patent and prayed for an injunction and other relief;

(2) These defendants are not informed, save

34 by said Supplemental Bill, as to whether or not on or about November 27, 1909, or at any other time, said Orville and Wilbur Wright assigned and transferred unto The Wright Company the whole right, title and interest in and to said Letters Patent 821,393 and all rights of action and recovery for past infringement, or that said The Wright Company now holds the entire or any title thereto, or all or any rights of action for past or future infringement, and therefore leaves complainant to make such proof thereof as it may be advised is proper.

35 (3) These defendants further answering allege that said Supplemental Bill filed by The Wright Company, is improper, insufficient in law to make said The Wright Company a party to the suit, or to entitle it to the relief prayed for or any relief against these defendants, or either of them, and is illegal, void and of no effect.

(4) These defendants, further answering upon information and belief, say that said complainant, The Wright Company, has no right to any further answer to said Supplemental Bill, or to any part thereof, than is herein contained, and is not entitled to any judgment, account, damage, or
36 any other relief against them, or either of them, all of which matters and things these defendants are willing to aver, maintain and prove as this pray to be hence dismissed with their reasonable Honorable Court shall direct, and they humbly costs and charges in this behalf most wrongfully sustained.

HERRING CURTISS COMPANY and
GLENN H. CURTISS,

By Emerson R. Newell,
Counsel for Defendants.

Jan. 10, 1910.

UNITED STATES CIRCUIT COURT, 37

WESTERN DISTRICT OF NEW YORK.

THE WRIGHT COMPANY,
vs.
THE HERRING-CURTISS COMPANY
and GLENN H. CURTISS.

In Equity No. 400.

New York, N. Y., September 8, 1911.

Testimony for Defendants under the annexed notice, dated August 31, 1911, commencing Sept. 38
8, 1911, at 11 A. M., at the office of Emerson R. Newell, #2 Rector Street, New York, N. Y., before Beatrice Mirvis, a Notary Public, in and for New York County, in the State of New York.

Present: H. A. TOULMIN, Esq., for Complainant.
EMERSON R. NEWELL, Esq., for Defendants.

Counsel for Defendants herewith introduces in evidence a printed article in the September, 1908 Century Magazine, on pages 641 to 650 inclusive
said article being entitled "The Wright Brothers 39
Aeroplane, by Orville & Wilbur Wright, with pictures and photographs supplied by the authors," and requests that the same be marked as "Defendants' Exhibit Wright Brothers Article in Century Magazine for September, 1908."

Counsel for Complainant waives proof by defendants of the article exhibit offered, but as the actual author of the article, Mr. Orville Wright, is not present but is in Ohio, 40 this waiver of proof is subject to correction if the article is incorrect in any of its statements or illustrations. Otherwise it is admitted without proof as having been written by Mr. Orville Wright personally.

As this article is not set up in the answer of Defendants, opposing counsel is requested to state briefly the object of its introduction in evidence.

Counsel for Defendants states that one object of the introduction of the article is to show what the Wrights, or one of them, has stated in regard to the matter at issue.

41 Counsel for Defendants herewith introduces a certified copy of the file wrapper and contents of the patent in suit #821,393, and requests that the same be marked as "Defendants' Exhibit File Wrapper & Contents Wright Patent In Suit."

Adjourned to 2 o'clock this afternoon.

AUGUSTUS POST, a witness introduced in behalf of Defendants, having been duly sworn, deposes and says as follows in answer to questions by

42 Mr. Newell:

Q1. What is your name, age, residence and occupation?

A. Augustus Post; age 37; residence 136 West 44th Street, New York; occupation, writer.

Q2. Did you make any experiments with aeroplanes with Mr. Glenn H. Curtiss in the early part of the year 1910?

Counsel for complainant objects to proof concerning alleged *ex parte* experiments conducted in the absence of complainant or

> its counsel and without notice to complain- 43
> ant. This objection is made once for all to any such testimony.

A. I did.

Q3. Have you any record made at the time, or within a few days thereafter, which would show what happened during those experiments? If so, please state what that record is.

> Same objection repeated as to any alleged records.

A. I have an affidavit made at that time which
refers to experiments made at Hammondsport, New 44
York.

Q4. I show you here a copy of the transcript of record in the above entitled suit before the United States Circuit Court of Appeals in the appeal from the order granting the preliminary injunction. On pages 348 to 356 inclusive, is your affidavit. Is this the affidavit you have just referred to?

> The question is objected to if it is intended to introduce this affidavit in evidence as the testimony of the witness, since the same is incompetent, being an *ex parte* statement. This objection is made once for all.

45

A. It is.

Q5. Will you please describe the experiments made at that time. In doing so you may use this affidavit to refresh your mind if you desire, for the affidavit was executed February 21, 1910, which is over a year and a half ago.

> By Counsel for Complainant: It appears that the witness is about to extract his answer from the affidavit, as he has a copy of the affidavit in his hand and is making ready to follow it, instead of testifying in-

46 dependently. Such a procedure is objected to as irregular and incompetent. This objection is made once for all.

A. On February 10, 1910, I went to Hammondsport, New York, for the purpose of assisting in some tests of an aeroplane which was made at that place, and to see if the use of side balancing planes in the machine which was made by the Herring-Curtiss Company would or would not deflect the machine out of the straight course ahead while in flight, and whether or not it was necessary to use the rear vertical rudder to counteract any such turning tend-
47 ency. Several flights were made under varying conditions. The machine was the usual type of the Herring-Curtiss Company, having two rigid curved supporting surfaces, a front horizontal rudder consisting of two small planes fixed to a suitable framework which could be tilted up and down in order to guide the machine up or down, and which frame-work carried a fixed vertical surface. At the rear of the machine was a fixed substantially horizontal, plane, and pivoted to it was a rear vertical rudder. The rear rudder was operated by suitable wires passing around a steering wheel pivoted on a steering post, which post could be rocked forward
48 and back and which was operatively connected with the front horizontal rudder frame by bamboo rods, the lateral balancing of the machine was accomplished by two surfaces which were nearly flat, and located between the main supporting surfaces, one at each side of the machine, being pivoted to the connecting rods at their forward edges, and were rocked on their pivots in opposite directions and to equal angles from the normal when the balancing was accomplished, by means of wires which ran to a pivoted frame-work enclosing the operator's shoulders. These planes were normally in the

same horizontal plane and so located that there 49
would be no lifting effect produced by them when
the machine was in normal flight in a horizontal
direction. The machine without operator weighed
about 400 pounds. I am informed and believe, and
Mr. Curtiss' weight I am informed, was at the
time about 150 pounds. The temperature of the
air was about 10 degrees Fahrenheit. The wind
was light from the southwest and at first was about
six to eight miles per hour estimated. The machine
is shown in the attached "Post Photograph No. 1"
and was substantially the same as shown in "Defendants' Exhibits Photographs of Defendants'
Machine," in the record on preliminary injunction. 50
I recognize that if a flight with such a machine is
made in an absolutely horizontal direction and with
the balancing planes so set that their normal position is absolutely horizontal during the normal
horizontal flight of the machine, these balancing
planes will, when moved to equal but opposite
angles from the normal horizontal, exert exactly
the same resistance at each side of the machine, and
consequently give no turning tendency when so
moved. Even assuming that if the normal position
of the balancing planes is not changed and the machine flies upward while carrying the same weight,
or if a greater weight is added so that the machine 51
has to be slightly tilted up in order to support
such greater weight, and so that the balancing
planes in their normal position would exert a slight
lifting effect, and that if such planes are then moved
in opposite directions but to equal angles from the
normal, a somewhat greater resistance or drift
would be exerted by one plane over the other, and
thus give a somewhat greater resistance at one side
of the machine over that on the other, theoretically
this, if continued and unopposed might give a tendency to the machine to turn around a vertical axis

52 toward the side on which a greater resistance is offered, and theoretically the rear vertical rudder might have to be moved to counteract such turning tendency if it were desired to keep the machine in a straight course ahead. The inertia of the machine and the gyrostatic action of the propeller which rotated at one-thousand and forty revolutions per minute, and the fact that when lateral equilibrium is lost, it is regained by the use of the balancing planes almost instantaneously, as their use for this purpose is only for a second, all combined to introduce factors which might negative any possible turning tendency, or make it infinitesimal and
53 negligible. It was for the purpose of ascertaining the true facts in regard to the above that the test flights, hereafter described, were made.

On the morning of February 11, 1910, at about 9 o'clock A. M., the machine was brought out and Mr. Curtiss operated the same, making one flight, first, for the purpose of testing the engine to see if it were running properly. The amount of gasolene carried on the machine was substantially two quarts. At the above trial flight I placed the vertical rear rudder in the geometrical center line of the machine, so that if not moved it would not deviate the machine from a straight-away flight, and
54 assured against undetected movement of it by gluing a strip of paper to the steering wheel and the post on which it was pivoted, so that it was absolutely impossible to rotate the steering wheel, or in any way move the vertical rudder without breaking the paper seal. I also tied the steering wheel with a light cord. The seal and cord are shown in "Post Photograph No. 2," hereto attached.

The balancing planes were set in their normal position, as above described, that is, so that they were both located in the same plane and exerted no, or substantially no, lifting effect when the machine was flying horizontally at its normal angle of flight.

At 9:37 A. M., Mr. Curtiss started the machine 55
from near the shore of Lake Keuka and flew in a substantially westerly direction. I stood substantially in the center, between the point where the machine left the ground and the point where it first touched the ground, the machine passing over my head. This distance of free flight in this first test was substantially 510 feet (all the flying field permitted) and, as the ground rose somewhat from the point of start to the point of landing, the flight was in a somewhat upward direction from the absolute horizontal. I instructed Mr. Curtiss to operate the balancing planes during each of the flights
so as to lose and regain the lateral equilibrium of 56
the machine, and I watched the machine carefully during all the flights so as to make sure that the balancing was accomplished in each direction, and to ascertain whether or not it did turn or swerve the machine. I could see every movement plainly. Mr. Curtiss, in this flight, did lose and regain the machine's equilibrium in both directions, that is, each side of the machine was tilted both up above and down below the horizontal more than once, and the machine was steered up and down by the use of the front rudder, the balancing being regained by the use of the side balancing planes. I
distinctly observed that the machine did not turn 57
or swerve out of its course when the balancing was done. The machine landed, and I went up to it and examined the paper seal and the cord on the steering wheel. They were both intact and in exactly the same condition as when I first put them on, showing that the steering wheel, and consequently the vertical rear rudder, had not been moved at all. Three flights under exactly the same conditions, and with exactly the same results, were then made.

In order to further test the machine by increasing the angle of incidence on the main supporting

58 surfaces over the angle of incidence in the above
flights, so as to create a greater difference of resist-
ance when the balancing planes were moved, we
put five gallons additional gasolene into the tank,
thus adding from 30 to 35 pounds weight, which
would, of course, necessitate a somewhat greater
angle of incidence of the air rush upon the main
supporting surfaces over what it was in the pre-
ceding flight, providing the speed was not in-
creased. I could not observe that the speed was
increased, and Mr. Curtiss in his affidavit states
that the propulsive power used was the same at
all times during all the flights, and I believe this
59 to be correct. This proves that the angle of inci-
dence must have been greater than the normal in
order to support the added weight. The normal
position of the balancing planes was not changed,
and on account of the greater angle of flight the
difference of resistance at the two sides of the ma-
chine offered by the balancing planes when moved
in the act of balancing, was increased over that in
the preceding flight. The air in this flight was
almost still, being estimated to move at about five
miles per hour. The rear vertical rudder was
sealed by me as before, and Mr. Curtiss made a
flight at 10:30 of substantially 540 feet between
60 the point where the machine left the ground and
its landing on the ground again. I stood between
the points of leaving the ground and landing, and
in the direct line of flight of the machine. During
this flight Mr. Curtiss lost and regained the lateral
equilibrium of the machine several times, and I
could distinctly see the machine tilt in each direc-
tion, and see the balancing planes move to bring
the machine back to equilibrium. Mr. Curtiss lost
and regained his equilibrium more than once in
each direction during this flight, operating the bal-
ancing planes in both directions several times in

order to do so. I distinctly observed that the ma- 61
chine was not deflected out of its course by such use of the balancing planes at any of the times when they were operated. The machine landed with the seal unbroken and intact, showing that the steering wheel could not have been rotated, nor the rear rudder moved.

At 10.39 A. M. another flight was made under the same conditions as the last one. I instructed Mr. Curtiss particularly to use his balancing planes, with exaggerated effect, that is, to move them to an exaggerated angle in balancing so as to rock the machine back and forth in an exag-
gerated manner. He made this flight with the 62
steering wheel sealed as before, and I observed him losing and regaining his equilibrium in both directions and using the balancing planes with this exaggerated effect, yet I could detect absolutely no turning tendency given to the machine. I stood substantially in the middle of the flight and in such position that one of the posts (1 on Post Photograph #1) connecting the two main supporting surfaces at the front edge of the machine was in line with the corresponding connecting posts 2 at the rear edge, so that if the machine had been deflected in either direction, such posts
would have moved out of line with each other. 63
Although balance was lost and regained during this flight, and more than once in each direction, and with an exaggerated effect, the machine kept a straight course and, although I could have seen the posts plainly, if they had moved out of line with each other, they did not do so but remained in almost perfect alignment during the entire flight, and there was no swerving of the machine, when balance was lost or regained, or any swerving which could be detected at any time when the balancing planes were operated. I would have

64 noticed it if there had been. The machine landed with the seal intact, and the rear vertical rudder could not have been moved during this flight.

In order to still further increase the difference of resistance at the two sides of the machine by the use of the balancing planes, we took the machine out onto the frozen surface of Lake Keuka, over one-half mile from the shore, and tied onto the frame-work of the machine several feet in front of the operator a stone weighing eleven pounds, 12 ounces, as shown in "Post Photograph #3." I sealed the steering wheel as before, and Mr. Curtiss rose from the ice in the machine and
65 flew in a westerly direction substantially one-half mile, balancing in both directions several times as before, and while both rising and descending. I carefully noticed the flight and this loss and regaining of balance in each direction, and the use of the balancing planes for this purpose, and yet there was no swerving or turning of the machine whether the machine was rising, flying horizontally, or descending, at the time the balancing was accomplished. The machine landed with the seal unbroken and intact as before.

In all these flights my attention was particularly directed to noticing whether or not there was
66 any swerving or turning of the machine when the balancing planes were moved, and I can positively state that even with the closest attention I could not detect that any turning or swerving occurred. The flights were purposely made short, particularly the ones before the last, and I am confident that I would have detected even a slight swerving or turning.

At 11.30 A. M. I made several flights in the machine myself, probably ten or twelve, as I did not keep an accurate record of the number. In these flights the steering wheel was not sealed, as I had

not previously flown a machine of this type. In 67
these flights I lost and regained the equilibrium of the machine in both directions by the use of the balancing planes, and I positively state that I could detect no swerving or turning of the machine at any time such balancing was accomplished, nor did I move the vertical rudder in any way when balancing.

From the flights which I personally made in the machine, and the flights which I saw Mr. Curtiss make, I can positively state that in all of them and under all conditions of flying upward, downward, horizontal, and with a greater or less
weight carried, there was absolutely no turning of 68
the machine around a vertical axis when the balancing planes were moved, so far as I could detect, and I paid particular and close attention to observing this point, for the tests were for the purpose of determining whether or not this was a fact. In practical operation the vertical rudder is used solely as a steering rudder and, the same as the rudder of a boat, it is entirely divorced from any necessary combination with the greater or less angle of incidence of the balancing planes, and it is not necessary to move it in any direction in order to keep a straight course when
the balancing planes are moved. I recognize the 69
theory of operation which complainants in this case have advanced, and which they seem to consider must necessarily turn the defendants' machine when the balancing planes are moved, but whatever may be the theory in this respect, the fact is, from personal observation and personal practice, that no such turning or swerving was to be detected at any time or under any condition. I believe that this is due, for one thing, to the fact, that, as the balancing planes are used only for a moment in regaining equilibrium, any difference of resistance

70 offered by them at the two sides of a machine continues for such a short time that it is not sufficient to overcome the inertia of the machine and the gyrostatic action of the propeller. I am not connected with either of the defendants in any way, and I am not interested or affected in any way by the outcome of this cause.

By Mr. Toulmin: As the witness has merely read his affidavit of Feb. 21, 1910, in giving his last answer, the same is objected to as incompetent and as an irregular mode of taking testimony. Notice is given
71 that a motion will be made on or before the day of hearing of this cause to expunge or suppress said answer. Notice is also given that at or before the hearing a copy of the said affidavit, or the original now on file, will be offered in evidence by complainant, or be referred to as a part of the Court record in the case so as to show the Court that the witness has merely read or copied the affidavit in giving the answer, with one or two immaterial verbal changes, such as "Mr. Curtiss" instead of "he."

Counsel for defendants states that there
72 is considerable in the affidavit which is not in the above answer, as will be seen by comparing the two, so that the statement above by opposing counsel is hardly exact. Ample opportunity will be given to the opposing counsel for cross examination. It is believed that a record made within a few days of the events which occurred more than a year and a half ago is more likely to be accurate than mere recollection at the present time.

Q6. You have referred to three photographs as

"Post Photographs Nos. 1, 2 and 3." If these are the ones which I now show you, please so state. 73

A. They are.

> Counsel for defendants requests the Notary to inital the same for identification.
>
> (The Notary does so.)
>
> The photographs are objected to as incompetent, having been taken as part of the *ex parte* proceeding when the alleged tests were said to be made.

Q7. Was there any device on this machine by which the drift on the balancing planes was caused to be equal? 74

A. No, there was no device to cause them to be equal.

Q8. I show you here Complainant's Exhibit "Drawing of Defendants' Machine." The wires for operating the ailerons are shown in red. Were the wires on the machine you have been testifying about arranged in the same way?

A. They were substantially the same.

Q9. Since those tests, about which you have just testified, have you flown a machine like it and with the balancing planes arranged in the same way. If so, please state roughly how many times and how long such flights were? 75

A. I have. In the neighborhood of twenty-five times on short flights. I am unable to tell the duration, short flights of one or two minutes each.

Q10. Was two minutes the longest flight?

A. No, I should say that was the average.

Q11. How long was your longest flight? I mean roughly.

A. Perhaps five minutes.

Q12. In such flights did you operate the machine yourself, or did someone else operate it and you go along as a passenger?

76 A. Both. I operated the machine and also rode as a passenger.

Q13. This was a power-driven machine?

A. It was.

Q14. At about what speed?

A. 45 miles an hour.

Q15. Was equilibrium lost and regained in those flights?

A. It was.

Q16. Could you, or could you not, during such flights detect any swerving of the machine when the ailerons were used in regaining equilibrium

A. I could not detect any swerving of the ma-
77 chine.

Q17. Did those flights made by you since the tests in February, 1910, confirm or upset the conclusions at which you arrived from those tests and which you have expressed in your answer to Q5?

A. My experience since that time in the air and in the practical operation of the machine has served to materially strengthen my conclusions made at that time, and I have been unable to detect any swerving of the machine caused by the operation of the balancing planes while flying.

Q18. Have you had any experience in the operation of free balloons, that is, spherical balloons
78 float freely through the air. If so, please state in a general way what your experience has been.

A. I have had wide experience in the operation of free balloons. I have been one of the representatives of America in three International contests, and have assisted in the making of many American records, among which I might mention the winning of the International Gordon-Bennett race in 1910 with Mr. Alan R. Hawley in the balloon "America Second," starting from St. Louis, and landing in Canada, a distance of approximately 1200 miles.

Q19. About how many balloon ascensions have you made? 79

A. About in the neighborhood of fifteen, I should say.

Q20. From your free ballooning experience, are the rising and descending currents of air or side currents the most frequent causes of change in the position of the balloon as a whole in the air?

A. The balloon is affected by the current in which it happens to be in and it is quite as frequently caused to rise and descend by a rising and descending current of the air, as it is to be carried in a lateral direction.

Counsel for defendants herewith introduces in evidence the three photographs referred to by the witness, and requests that they be marked as Defendants' Exhibits "Post Photographs Nos. 1, 2 and 3," respectively. 80

By Mr. Toulmin: The photographs are objected to for the reasons already stated.

By Mr. Toulmin: Without waiving the objections made to the incompetency and irregularity of the witness's deposition in chief the cross examination is proceeded with.

XQ21. Of the twenty-five flights, you say you participated in, in how many did you operate the machine or aeroplane alone? 81

A. In all but three or four.

XQ22. When did you make these flights?

A. In 1910.

XQ23. About what months?

A. February, I think it was, from February up to December, last.

XQ24. You may state at what different places you made these aeroplane flights?

82 A. At Hammondsport, New York, New York City, Boston, Chicago, Cleveland, Mobile, Alabama and New Orleans.

XQ25. And you may approximte the distance you flew the longest in those flights?

A. I cannot be very exact as I had nothing to measure them by. I made circles around the Hawthorn racetrack in Chicago, and also flew in circles over the flying field in Mobile, which I think might have been in the neighborhood of four or five miles.

XQ26. And how long a time, do you say, you remained in the air on one of these flying machine trips; I mean the longest time when operating the
83 machine yourself?

A. I think it was something over five minutes.

XQ27. Did you ever fly an aeroplane at Sheepshead Bay, New York?

A. I did.

XQ28. Describe your experience in that flight?

A. I started in a Curtiss machine from the West end. What flight do you refer to?

XQ29. If you made more than one aeroplane flight at Sheepshead Bay, state how many and the time you made each?

A. I was practicing on the field for something like two weeks, and I made many flights of short
84 duration, many of them the full length of the field, many averaging something over a minute, and I flew during one of the meets held there over the field, circling in both directions, returning approximately to near the starting point.

XQ30. But you have not described your experiences in these Sheepshead Bay flights? Please do so.

A. During these flights I operated the controls of the machine to their fullest extent, both the fore and aft control and the control of lateral balance. I circled in both directions by the use of a

vertical rudder and I tested out the machine to 85
my complete satisfaction. During my experience with the balancing planes of the machine in flights made at that place, I could detect no tendency to turn the machine or swerve it from its course by their use. I had an ample opportunity to judge during the flights which I made at that place.

XQ31. You seem to omit the description of your experience in one of those flights when you came down with the machine tossing in one direction or another and rocking violently. I wish you would do so.

A. I don't remember any such case, nor any
case when the machine was out of my control, and 86
I think the rocking which is referred to means the banking of the machine while making short turns about the field, in order to secure a good position for a safe landing.

XQ32. Well, then, please describe the experience you had with the machine at the times indicated in your last answer?

A. In regard to what respect?

XQ33. In all respects, from the time you left the ground until you got back.

A. Do I understand you like to have a—please divide the question a little more definitely?

87

Adjourned at 4.40 to tomorrow, Sept. 9th, at 10 A. M., at the same place.

New York, N. Y., September 9, 1911.

Met pursuant to adjournment.

Present—Counsel as before.

XQ34. As you do not seem disposed to go right on and state your experiences at Sheepshead Bay, I will pass that subject for the present.

88 In the machine you have flown, the angle of incidence of the supporting planes change from one angle to another, while the machines were in flight, at times when their speed varied, did it not?

> Counsel for defendants, in view of the first sentence above, suggests that the witness is perfectly willing to answer any questions in regard to the flights, but by his reply to XQ33, shows that he does not know what sort of experiences counsel is asking him to give. The questions were therefore indefinite in this respect, and it is
> 89 suggested that if counsel wishes to know what such experiences were, he explain just what he means.
>
> Counsel for complainant replies that the matter was a simple one calling merely for the witness's experience at a stated place.
>
> By Mr. Newell: Experiences as to what? Sensations of flight, operation of the machine, or what? It seems to me you can make your question definite if you wish to.

A. In regard to the flights referred to, after leaving the ground at the westerly end of Sheeps-
90 head Bay track, New York City, the machine which I was using rose easily to a height approximately 100 feet and proceeded at this elevation from the point of attaining it, to three-quarters of the distance across the infield of the track. During this time balancing of the machine was necessary upon several occasions, and the balancing planes were used to regain the equilibrium which was lost. The machine itself was not swerved out of its direct path during this part of the flight, and the rudder was not used in any manner to correct any deviation from the direct

path in which the machine was flying. Upon ar- 91
riving at the far end of the field, I lowered the elevating plane and descended to the ground in ample distance to make a landing. A slight rise of the surface of the ground at this point caused the front wheel of the machine to rise sufficiently to allow the air to get under the main surfaces of the machine at such an angle that the machine rose from the ground and it was necessary for me to continue my flight beyond the end of the field to circle to the right and again circle to the left and to return over the central portion of the field, to circle and turn again to bring the machine into the wind, which was done and a perfect landing 92
was made at a little distance from the starting point of the aeroplane. During the circling flights the balancing planes of the machine were used to the limit of their movement in both directions. The elevating plane was also used to the limit of its motion and the relative effect of the controls was clearly revealed to me. There was no required movement of the rudder in connection with the use of either of the above-mentioned controls and the rudder was used independently by me for steering the machine and directing its course in its path above the surface of the ground.

XQ35. Do you mean by the last portion of your 93
answer that you used the rear verticle rudder to maintain the machine in its course while you were manipulating the balancing planes in connection with recovering lateral balance?

Counsel for defendants objects to the question as indefinite, as it does not clearly appear whether counsel means that the rudder was used merely as a steering rudder or whether used in order to regain balance.

A. No, I do not mean that there was any

94 connection between the operations of steering and maintaining equilibrium. The rudder, as stated in my answer, was used independently for directing the course of the machine while circling and steering, to obtain the proper direction for landing and hitting into the wind. During the first part of a flight which was practically straight-away, balance was lost and regained and corrected by the balancing planes, without moving the vertical rudder in the rear of the machine.

XQ36. Then do you mean to say that you held the vertical rudder stationary while manipulating the balancing planes?

95 A. I did not move the rudder.

XQ37. And do you say that you did not move the rudder at all at any time while you were manipulating the balancing planes, or did you sometimes manipulate the planes and operate the rudder at the same time?

A. On turns, it is possible that the rudder may have been set and maintained in a certain position, during which time the banking of the machine may have been corrected by the operation or use of the balancing planes, but this does not mean that the machine was swerved
96 in any way in its desired course, which it would naturally take under the influence of the vertical rudder.

XQ38. Then it does appear from your last answer that there were times when you manipulated both the vertical rudder and the balancing planes. Is it not also true that you sometimes turned the rudder first toward one side and then toward the other side of the machine, at the same time you were manipulating the balancing planes?

A. There was no simultaneous movement of the rudder and balancing planes. Independent

operations of one or the other were made during 97
such times as the machine was desired to be
directed in a changed course, or the lateral
balance of the machine corrected.

XQ39. Then is it correct to say that when
you desired to direct or control the course
of the machine while you were recovering lateral
balance, you manipulated the rear vertical rudder
and the balancing planes at the same time, either
simultaneously or closely following each other?

A. It is possible that the rear vertical rudder
might be turned at such a time and remain
turned, as a movement could be made by the
balancing planes, especially in the case of turn- 98
ing or circling the machine, but I do not ever
recollect a case where the two operations were
ever simultaneously made or required, or nearly
so. The machine takes a natural bank when
rounding a curve and if nicely adjusted, will
maintain its equilibrium. I flew at Hawthorne
racetrack in Chicago when Mr. Willard in another
machine flew directly in front of me, sending
the air wash of his machine directly back upon
my machine, causing disturbances in the air
which required use of the balancing planes with
great activity. The machine continued in its 99
direct course until it passed out of this dis-
turbed condition of the air, and the vertical
rudder was not used upon this occasion in any
manner during this experience.

XQ40. You base your statement that you did
not manipulate the vertical rudder and the bal-
ancing planes at or nearly at the same time,
upon your failure to recollect any such occasions.
You will not say, Mr. Post, here on your oath,
that you may not at times have manipulated the
rear vertical rudder at the same time that you

100 manipulated the balancing planes, or substantially at the same time, will you?

A. I should have recollected it if I had, and the two operations are so distinct that it takes two processes of thought to cause the two distinct movements, and I do not think that I could do both at the same time.

XQ41. Then you simply leave the matter upon the statement that you do not recollect having thus manipulated the rudder and balancing planes. Is that substantially correct?

A. I would repeat my answer and say that I think its goes a little further, and means that there
101 is no relation between the two movements.

XQ42. But you are not willing to go to the extent of your stating on your oath that you had not, or may not, have operated the rear vertical rudder while or during your manipulations of the balancing planes?

A. I will say that I have manipulated one, and then I have manipulated the other, but not simultaneously, nor as a sequence or an action following the action of the other, and I have not operated them simultaneously.

XQ43. Then I understand you to say that during the act of recovering lateral balance and while
102 the recovery was being effected, you operated, within such period, the rear vertical rudder and the balancing planes. Is that substantially correct?

A. I did not refer in my answer above to the matter of balancing. I referred solely to the movement of the balancing planes, and such movements as occur on a turn where the machine is banked, and where the vertical rudder is turned for changing the direction of the aeroplane.

XQ44. Then I will ask you if while traveling in such a curve as you have alluded to, you have manipulated the rear vertical rudder within the period in which you were manipulating the balancing planes to maintain lateral balance? 103

A. The rear vertical rudder may have been in a position at an angle to the middle line of the machine at such a time as the balancing planes may have been set off of the horizontal.

XQ45. And that answer applies also to similar conditions while in a straight-away flight? Does it not?

A. No, in a straight-away flight a movement of the rear vertical rudder turns the machine and changes a straight-away flight into one that is not straight-away.

XQ46. Then your last answer brings us back 104
somewhat to where we started. For this reason I will ask you if you are prepared to testify that you have not manipulated the rear vertical rudder within the period you were manipulating the balancing planes to recover lateral balance?

> Counsel for defendants does not desire to put objections upon the record any more than is absolutely necessary, but the word "manipulate" is rather indefinite, as manipulations may be made in various ways, and counsel is requested to make his meaning more definite, in order that the question may 105
> not be ambiguous.
>
> By Mr. Toulmin: As the term "manipulation" is used in connection with the function of recovering lateral balance, there is clearly no ambiguity.

A. It will be necessary for me to repeat the testimony given and to differentiate between straight-away flights and circular flights.

XQ47. Well kindly do so, briefly, with respect to your manipulation of the rear vertical rudder within the period you were manipulating the balancing

106 planes for recovering lateral balance, answering first as to flights in curves, and secondly as to straight-away flights.

A. In curved flights the rudder may be moved and remain in a moved position while the balancing planes are used. In a straight-away flight while the machine is going in a straight line, I have not used the rudder at such times as the balancing planes have been used.

XQ48. Under the conditions named in the first branch of your last answer, as to curved flights, you have manipulated the rudder by turning it in, first, one direction, and then the other, during the
107 period of the manipulation of the balancing planes. Is that correct?

A. No, I mean to say that the rudder was turned and remained turned in its substantially same position while any movements of the balancing planes took place, and the rudder was not turned from one side to the other during this period.

XQ49. But under your own theory, would you not have to turn the rudder from one side of the longitudinal center to the other under the conditions named in your last answer, if it were necessary to ease up on the curvature of the flight, say, to make it widen out on a longer radius as might
108 be the case if you came too near a fixed object on the inside of the curve?

A. I would like to make my answer in two parts. First, I should like to know what you mean by my theory?

XQ50. By "your theory" I simply mean even supposing you are right in the machine you have flown, the rudder is used solely for steering.

A. My second answer is that the change in the curve is not made during the period of balancing.

XQ51. Do you mean to say that in actual flight if the machine loses lateral balance while on a

curve, and the course of the machine is about run- 109
ning into a fixed object, you can stop to recover the lateral balance and then later manipulate the rudder to steer away from such object? Your last answer seems to mean this.

A. No, I do not think it does. There are other things to do.

XQ52. Then if while on a curve you were about to run into a fixed object and discovering that your machine at the same time was thrown out of lateral balance, would you not at once manipulate the rear rudder and the balancing planes, and not wait to operate either after the other?

A. Please locate the fixed object more definitely. 110

XQ53. I said in my last question that the fixed object was in such position as that the machine was about to run into it, so that the machine required immediate manipulation to prevent it. With this explanation, will you please answer the last question?

A. Not necessarily.

XQ54. Under the conditions named, if you delayed changing the course of the machine to avoid the fixed object, you might run into it, while on the other hand if you delayed manipulating the planes to recover lateral balance, you might fall. You
would have those alternatives simultaneously on 111
hand. Under those conditions do you mean the Court to understand that according to your ideas it would not be necessary to manipulate the rudder within the period you were manipulating the balancing planes?

A. I do. I wish you would definitely state which rudder you referred to?

XQ55. You must know that I was referring to the rear vertical rudder as that is the only rudder we have been mentioning in this series of questions.

A. I assumed that to be the rudder which was re-

112 ferred to. I would like to suggest that under the circumstances mentioned as I gathered them, it might be possible to pitch the machine down and avoid the fixed object, in that way without any change of the rudder or balancing device.

XQ56. But if that could not be done, and it could not be under the conditions we are discussing, then do you still say that according to your idea with the machine you have flown, you would, under the conditions named, not operate the rear vertical rudder within the period of operating the balancing planes?

A. It is quite possible that no change would need
113 to be made in this regard, that is, in regard to the balancing planes, rear rudder or elevator.

XQ57. I think your last answer leads this matter to an uncertain state, which would not satisfy the court. I wish therefore you would say "yes" or "no" to the proposition we are discussing and as embodied in the last question.

A. I would not care to leave any doubt as to my meaning and in the machine which I flew. It was possible to change the speed of the machine and quite possible to pass the point of obstruction referred to by slight rise, assuming of course that the indefinite conditions as stated would allow such a
114 procedure, and this could be done without other changes if the conditions, as I have said, were such that this could be done.

XQ58. But confining the answer to the conditions assumed in the series of questions, and understanding that the fixed object was such that the machine, under the conditions, could not pass over or under, then I will ask you whether in such a situation you mean to say you would not manipulate the rear vertical rudder within the period of the manipulation of the balancing planes to correct the lateral balance?

A. I have not had such an occasion arise, and I cannot say what I would do under a state of assumed condition. I think it is very rare among the many things that can be done, many of which may be effective, to state what one would do. 115

Adjourned at 12 o'clock to Monday, Sept. 11th, at the same place, at 10.30 A. M.

Counsel for complainant states that he does not think it fair to complainant to work but half a day, considering that Mr. Wilbur Wright and his counsel are here from Ohio under notice that these depositions will be taken, presumably within the 116
spirit of the Court's order.

New York, N. Y., Sept. 11, 1911.

Met pursuant to adjournment.

Present—Counsel as before.

Counsel for defendants states that the reason why only a half day's testimony was taken on Saturday, was because he had to leave to take his family away from the Shore and shut up the cottage. This necessity of adjournment at 12 o'clock was 117
explained to counsel for complainant at the beginning of the testimony on Saturday morning.

XQ59. In your affidavit filed in this cause and embodied in your fifth answer, you speak of the greater angle of incidence of the main planes causing a "difference of resistance at the two sides of the machine offered by the balancing planes when moved in the act of balancing." This difference of resistance at the two sides of the machine would cause a swerving or turning of the

118 machine on a vertical axis unless prevented by some means, would it not?

> Counsel for defendants objects to the question as improper cross examination, as the witness was not introduced as an expert in the art, but only to tell what actually happened. This objection is put on merely to save the defendants' rights in the matter, and it is not desired to repeat it after every question, even if this course of examination is further continued.

A. I distinctly observed that the machine was
119 not deflected out of its course at this particular time, and my further experience in operating the machine myself has clearly demonstrated to me that the machine does not swerve out of its course when rising or descending, and it is not necessary to move the vertical rudder. I have had ample opportunity in my position as Secretary and Representative of the Aero Club of America through many years, to witness almost all of the important flights made in this country, and I have also operated a machine of the type in question and ridden as a passenger, when
120 I have been able to observe and personally test this particular point, and I can clearly state that there is no relation in the practical operation of the machine which is referred to between the operation of the balancing planes and the rear vertical rudder, as far as maintaining balance of the machine is concerned. The operation of each of these particular functions of the machine is entirely separate, that is, the balancing planes are used to balance the machine independently of any other function of the machine, and the vertical rudder is used for steering the machine and directing its course.

XQ60. I do not regard your reply as an answer 121
to the question. Do you affirm or deny that the machine would have a swerving or turning on its vertical axis under the conditions named in cross-question 59?

A. In answer to the question I would repeat that the machine was not turned out of its course at the time indicated and under the conditions referred to.

XQ61. Well, then, is your answer to XQ59 in the affirmative or in the negative, which?

A. I can only repeat the fact and ask that the question be put in some other form and made
more definite. 122

XQ62. I regard the question as ample for the Court and for you, and therefore again request you to answer whether or not you say "yes" or "no" to XQ59.

> Counsel for defendants states to the witness that he is not obliged to answer "yes" or "no" to any question if another answer will more fully express his meaning.
>
> Counsel for complainant states that such is not the rule of law on the subject, as will be pointed out at the hearing, and the
> answer is insisted upon. 123

A. I am testifying to the facts in the case of the operation of the machine, and as to what occurred at this particular time. There are many elements which control the action of an aeroplane in the air, and if the question means to refer to some conditions or set of conditions which did not exist, the result might have been different. If you will make your question a little more definite, I may be able to answer it more fully.

124 XQ63. The question does not refer to any conditions that you yourself have not named. But you have sought to confine your answer to the particular occasion of what you saw while Mr. Curtiss was making a so-called test. I will therefore again ask you to state whether you affirm or deny that the machine would swerve or turn on a vertical axis unless prevented by some means, when under the conditions named in XQ59. In answering, do so irrespective of the flight you have been referring to, and base your reply on what you think to be your experience or not.

125

Counsel for defendants states that XQ59 referred to a particular test made as stated in Mr. Post's affidavit. The witness was introduced to testify to what happened, and not to theories. If the question calls for speculation as to what might or might not happen, it is objected to as beyond proper cross examination. This is what seems to be called for by the question now in view of the last sentence thereof, and the witness is instructed that he is not obliged to answer the question except as to the facts of
126 what occurred.

By Mr. Toulmin: XQ59 does not refer to any particular occasion and opposing counsel has no right to to indirectly instruct the witness to that effect by making that assertion on the record. Moreover, the last preceding question gives the witness the opportunity to now answer, irrespective of the particular test referred to. It is an unlawful interference with the right of cross examination for opposing counsel to instruct the witness as he has, when the witness has qualified as having made alleged flights of

his own, which if true would enable him to 127
answer what is now propounded. An answer is therefore insisted upon.

Counsel for defendants states that when XQ59 was asked Mr. Post, the witness, asked Mr. Toulmin what part of the affidavit he was referring to, and Mr. Toulmin informed him that it was on page 353 where Mr. Post was describing what happened in the test when five gallons additional of gasolene were put into the tank. Counsel presumed, and he believes that the witness also presumed, that the question was directed to
this test. If, however, the question is now 128
to be broadened out to merely theoretical matters, about which the witness has not been examined, the cross examination is not proper, and the witness is again instructed, that, until otherwise ordered by the Court, he need not answer the question as to anything beyond what actually occurred. In other words, he need not go into speculations as to theories.

By Mr. Toulmin: XQ59 contains merely a quotation of the fact as stated by Mr. Post in his affidavit as repeated in his pres-
ent deposition. If he assumed that the 129
question referred to the particular test, he has mentioned in his answer, the last question makes the matter perfectly plain and he is therefore requested to answer it, one way or the other, in the light of what he claims to be his knowledge on the subject of operating flying machines of the kind in question. The question calls for an answer on the matter of fact.

A. When flying a machine of this type, my ex-

130 perience has been that when rising or descending I have not been required to prevent swerving of the machine from any cause which may have arisen from this particular condition, which I understand is the one that is referred to in the question. The machine in rising and descending has maintained the straight course and the operation of the rear vertical rudder has not been necessary. This is the fact in the case.

XQ64. You limit your last answer to what you term "ascending" and "descending." Please answer the preceding question if when the conditions named arose you were flying in a horizontal course.

131 A. Please state what conditions you referred to as arising?

XQ65. I refer to the same conditions you referred to in your last preceding answer.

A. The reason of my question is that the conditions referred to in the original case had reference to the addition of extra weight upon the machine, which did not exist in the case to which I referred, but in flying horizontally and in the normal operation of the balancing planes, the machine is not swerved from its direct course by this process.

XQ66. Whether the machine be flying horizontally or descending or ascending and a differ-
132 ence in the resistance offered by the balancing planes at the two sides of the machine occurs, does not the machine, due to such difference in resistance, swerve or turn on a vertical axis and require something to prevent that turning or swerving?

By Mr. Newell: In view of the witness's statements several times that there is no such swerving or turning which could be detected, the question resolves itself into one of pure speculation, and the witness is

again instructed that he need not answer 133
it except as to what actually occurred, and need not go into speculations as to what might or might not happen, or what the causes might or might not be for what did actually happen.

By Mr. Toulmin: The last objection is a clear attempt to make it appear that the question involves a matter of theory, when such is not the case, and the witness is merely being asked to state a fact as he understands it inherent in the operation of these aeroplane flying machines which he claims
to have flown. 134

A. In the machine as it is constructed and operated, it does not swerve or turn under the conditions to which I refer. If other conditions are assumed or desired to be introduced, I would ask that they be more definitely stated, and not merely assumed to exist. The machine does not require anything to be done by the aviator.

XQ67. Is it not a fact that in your experience with defendants' machine a difference in resistance at the two sides of the machine was produced by the balancing planes when moved in the act of balancing? 135

By Mr. Newell: What flight or test do you refer to?

By Mr. Toulmin: The question speaks for itself, and refers to the witness's experience in flying the machine.

A. Under normal conditions there is no difference occasioned by the operation of the balancing planes on this machine, and in ordinary flights the resistance occasioned by the use of one balancing plane is offset by the resistance of the other bal-

136 ancing plane, and there is no turning tendency imparted to the machine.

XQ68. Your last answer assumes that the angle of incidence of the general plane was fixed and constant, does it?

A. I said when the machine was in normal flight, and I did not assume anything.

XQ69. Well please explain what you mean by "normal flight," during which you say the resistance at the opposite side of the machine, offered by the balancing planes when being worked to recover balance, is the same?

A. By "normal flight" I mean when the machine
137 is proceeding in a direct course, neither ascending or descending, nor turning to the right or left.

XQ70. As your last answer connected with your several preceding answers comes to the point that the resistance is the same at both sides of the machine when in normal flight, as you call it, neither ascending or descending, please state the kinds of flight or circumstances when the resistance at the two sides is not the same?

A. One of the times is when the rear vertical rudder is turned to one side or the other of the machine.

XQ71. Please go on and name some other conditions of flight when the resistance at the opposite
138 sides of the machine is unequal on the balancing planes?

A. When the surface offered by these balancing planes might be different and the air pressure would be equal on both sides.

XQ72. And you may name any other conditions of flight when the resistance is unequal on the balancing planes at the respective sides of the machine?

A. The wind pressure might vary on one side or the other.

XQ73. And you will please name any other condition when such resistance is unequal on the balancing planes at opposite sides, one compared with the other? 139

A. I think this covers the conditions that occur while the machine is in free flight.

XQ74. Are those all you can remember now?

A. When the air pressure changes, or when the surface changes, which are the controlling factors under the conditions referred to. I do not see any other cause for unequal resistance on the balancing planes at the respective sides of the machine.

XQ75. By the expression "when the surface changes," you mean when one balancing plane is at a greater angle than the other balancing plane, do 140 you?

A. I mean when the amount of surface offered to the air differs.

XQ76. Differs on the balancing planes?

A. On the balancing planes.

XQ77. And these instances you have given of differences in the resistance on the balancing planes at opposite sides of the machine, are in addition to the instance you mentioned in the affidavit as embodied in your answer, are they?

A. To what specific conditions do you refer as embodied in the affidavit mentioned?

XQ78. Take the particular case of the difference 141 in resistance at the two sides of the machine mentioned by you in that part of your affidavit which is embodied in your answer to Q5 and occurs on pages 9 and 10 of your deposition.

A. I understand your question refers to the test in which additional weight of gasolene was added to the machine, and I think that the conditions stated in my answer to which you refer cover this particular condition present in this test.

XQ79. And still another instance is given by you in said affidavit and in answer 5, at page 12 of this

142 record, where you refer to adding eleven pounds and twelve ounces to defendants' machine to "increase the difference of resistance at the two sides of the machine by the use of the balancing planes," is it not?

A. My answer I think covers this condition referred to and quoted in your question. My answer and answers made above, XQs 70, 71, 72, 73, 74, 75 and 76, cover this particular condition which is referred to in your question, and it is not an additional condition.

XQ80. With the variation in the speed, but without material change in weight, the machines you
143 have flown will vary in their angle of incidence of the general planes while in flight, do they not?

A. Unless there is some counteracting influence, a greater speed would have a tendency to cause the machine to rise, and a slower speed to descend, and I think this might be accomplished without a great variation and possibly without a variation of the angle of incidence, or the set of the planes toward the direction of the air rush.

Recess.

XQ81. I do not think your last answer quite
144 meets the question. You introduce the rising and the descending of the machine. If the course of the machine were substantially horizontal, would not the variations in the speed, but without material change in weight, in the machines you have flown vary the angle of incidence of the general planes while in flight?

Counsel for defendants objects to this question, and any other along the line of the theory of flying as opposed to that of actual practice in flying, on the ground that the witness was not introduced as

an expert, or even familiar with the 145
theories under which a flying machine is operated, but only as to what happened according to his own observation. This objection, although not specifically repeated, is understood to stand to such line of cross examination.

By Mr. Toulmin: The objection is entirely superfluous, as no questions have been asked the witness on cross examination outside of what his alleged experience would cover. This answer is made once for all to such objections. 146

A. My answer to your question was an answer which followed the question as put. In regard to the present question XQ81, if the machine is kept from rising or falling by some "counteracting influence" referred to in my answer to the above question, the angle of the machine in flight might change to some slight degree.

XQ82. Is this "counteracting influence" you refer to the horizontal rudder for controlling the rise and fall of the direction of flight?

A. The change would probably have to be made in this horizontal rudder in order to
maintain the machine in a horizontal direction, 147
or to allow the machine to continue in a horizontal direction.

XQ83. And so while flying in a general horizontal direction and controlled in that respect by the horizontal rudder, the angle of incidence of the general supporting planes would vary with variations in the speed, the weight remaining substantially the same, while in flight? Is that correct?

A. This might be so, leaving out all questions

148 in regard to the varying speed or movements of the air.

XQ84. You say "might be so." If you know and therefore can tell the Court what the fact is, I wish you would kindly do so, or say that you are not certain.

A. I think this is the fact in the matter.

XQ85. That is, that the angle varies?

A. Yes, under the conditions assumed to exist.

XQ86. And the amplitude or extent of these variations in the angles of incidence under the conditions I have stated, would depend upon the extent of the variations in speed, would they not?

149 A. There are other considerations that enter with the varying of the speed and as a direct cause of the varying of the speed, so that any varying would have to take into account all of the changing conditions which occur when the speed is changed. I mean to say that it is not the change in speed alone which determines the difference or variation in the angle at which the machine flies. Resistances change, efficiencies change, as well as a change which takes place in the speed.

XQ87. And aside from that, or from those
150 things, in coming back to the last question, please answer as to whether the extent of the variation in the angle of incidence, under the conditions I have stated, depends upon the extent of the variations in speed, when speed is the cause of the angle of incidence being changed?

A. Speed, as I have stated, is only one of the factors in regard to this problem which you have presented. The relations of it to other factors may change and I think do change, so that I do not think that it is a variation in speed alone which governs the point under considerations.

XQ88. Kindly name all of the causes that 151
you know of which bring about the changes in the angles of incidence of the supporting planes while the machines you have flown are in flight?

A. I will do so as far as I can, and the main cause used to change the angle of the machine in flight is the horizontal control of the machine, or the horizontal surface which is used to control the direction of the machine in a vertical plane. An adjustment of the speed of the machine might cause it to change its angle of flight, an adjustment of the weight or balance of the machine might also cause a change in the
angle of flight. There may be other causes which 152
may occur to me later.

XQ89. I understand by "angle of flight" you refer to the angle of incidence, is that correct?

A. Please state what you mean by "angle of incidence?"

XQ90. I would have no objection to defining it, except for the fact that the object of this examination is to find out what you know and not what I know. If you do not know what the angle of incidence of the main planes of the machine you have flown, means, then I wish that
you would so inform the Court. Do you, or do 153
you not know?

A. I am anxious to answer the questions which are put in regard to the facts of this case, and my desire in asking for a definition of the term "angle of incidence" which was part of the question which was put to me, is in order that I may answer the question insofar as it refers to the facts in this case. I have assumed that in XQ88 which asks me to "name all the causes which bring about the changes in the angles of incidence of the supporting planes, while the

154 machines you have flown are in flight," means to name all of the causes which bring about the change in the angle of flight of the machine while in the air, and I have endeavored to do so.

XQ91. And during the operation of any of these causes which you have named as changing the angle of incidence or flight, and the consequent variation in such angle, does the machine you have flown from time to time need its lateral balance to be corrected by adjusting the balancing planes at times when the angle of incidence may be one or another angle?

A. The machine to which we refer does not
155 need the operation of the balancing planes by virtue of any of the above-mentioned causes, and it does not necessarily follow that the machine should lose its lateral equilibrium by any of these causes as stated.

XQ92. You have not answered my question. As the lateral balance of the machine you have flown has to be recovered at any time occasion requires, I wish merely to know whether it happens in practice that the lateral balance is recovered when the angle of incidence may be one angle at one time, and has to be recovered
156 when the angle of incidence is another angle at another time?

Counsel for defendants objects to the question as very much involved and ambiguous.

A. My answer fully answered XQ91 as it was put. Your question XQ92 I will answer and say that the lateral balance may be lost and regained at any time during a flight and it does not have to be recovered, or is it necessarily lost at any

time when the angle of incidence or angle of 157
flight to which you refer, may be at one angle "at one time;" or at another angle "at another time."

XQ93. In the machine you have flown, lateral balance has to be recovered, when the occasion arises, no matter what the angle of incidence may be at that particular time, is that correct?

A. The lateral balance of the machine is sometimes allowed to correct itself, and it is often that, in doing something else which may be of major importance, lateral balance will naturally follow. I think this answers your question. I
do not think it has a direct connection with the 158
angle of incidence.

XQ94. You have not at all answered my question. In the machine you have flown, when the time comes to recover lateral balance, the balancing planes are operated irrespective of whether at that time the angle of incidence of the main plane may be one or another angle. Is that correct?

A. It may not be necessary to operate the balancing planes at such a time as you state. Therefore your question is not clear in that
regard. 159

XQ95. Again you do not answer. I stated no time for the operation of the balancing planes to recover balance. I merely asked you whether in that machine the lateral balance is recovered, when the occasion requires it, irrespective of what the particular angle of incidence of the main planes may be.

A. The question XQ94 distinctly states "when the time comes to recover the lateral balance, the balancing planes are operated." This seems to fix a time, and my answer was "it may not be necessary to operate the balancing planes at such a time

160 as you state." In reply to XQ95 the lateral balance can be recovered should occasion require it irrespective of the angle of flight of the machine, provided there is nothing to interfere in the carrying out of the operation. That is, that there is freedom of action for the machine and no outside causes to prevent.

XQ96. When the resistance on one of the balancing planes is greater than on the other, as in any of the instances you have heretofore named, toward which of the balancing planes do you turn the rear vertical rudder to keep the machine in a straight course at that time?

161 A. I do not turn the rear vertical rudder at all in any such instances or cases. There is no necessity to turn this rudder. The machine is not swerved out of its course and proceeds in a straight direction, and I have had ample opportunity to personally test and observe this point. The rear vertical rudder is used for the direction of the machine and it is not necessary to use it because or on account of the operation or function of any of the other controls of the machine. This is the fact in the case.

XQ97. Under the conditions named in my last question, do you hold the rear vertical rudder sta-
162 tionary in a central position?

A. You are not required to do anything to it at all by virtue of any causes which arise, as you describe, or to which you refer.

XQ98. But you have not answered my last question. I simply asked you whether under the conditions named in the second preceding question from the present one, you held the rear vertical rudder stationary in a central position?

A. I said it was not necessary to hold it or to move it, and I refer to the rear vertical rudder.

XQ99. I did not ask you what is necessary. I

asked you what the fact was as to whether such 163
rudder is at such time held stationary in a central position. Please answer that?

A. If you will assume that the machine is proceeding in a straight line and it is not necessary to complicate the movement by the turning of the machine, it is not necessary to in any manner move or hold steady the rear vertical rudder, and I think it is quite possible to do nothing when there is nothing to be done, which is an answer to your question XQ99.

XQ100. You have not stated yet whether under those circumstances you do or do not hold the
rear vertical rudder stationary. Please do so. 164

A. My answer indicated that it is not necessary to hold the rudder stationary, or to move the rudder, and you are not required to do either one or the other under the conditions referred to.

XQ101. You still take cover under what is "necessary" and "required." These qualifications avoid the question. So I will again ask you to answer the last question.

> By Mr. Newell: Counsel believes that the question is unfair in the first sentence. The question has been answered more than once.

A. You do not hold the rudder stationary, and 165
you do not turn it.

XQ102. Do you, under those circumstances, let go the wheel which controls the cables that lead to the rear vertical rudder?

A. In the ordinary machine which we are considering, the wheel to which you refer controls also the elevating and depressing of the machine, and it is held only in so far as it has reference to that function of the machine.

XQ103. You mean the wheel is held from turning

166 or rotating at that time, speaking of the conditions you have been referring to?

A. No, I do not mean that it is held for the purpose of turning or rotating or preventing the same from turning or rotating, and the same effect to which I refer could be accomplished by holding the standard to which it is attached and operating the standard without any reference to the action of the rear vertical rudder, or any of the cables leading thereto. The machine has been flown when the rudder cord or cable has been broken, by Mr. Ely at Poughkeepsie.

XQ104. Then as a matter of fact, under the con-
167 ditions named, in holding onto the rudder wheel to control the horizontal rudder, the rear vertical rudder is either held in a fixed position or is turned at such time. Is that correct?

A. This is not necessarily the case. It is not necessary in any manner to turn the rear vertical rudder when the horizontal rudder is moved, and there is no connection between these two processes of elevating and depressing the horizontal controlling surface and the rear vertical rudder. If you will kindly ask the question in some other form and state the conditions again to which you refer, I will endeavor to answer your question more fully.

168 XQ105. To do this I shall refer back to XQ96 and your answers to XQs 101 and 102. When the resistance on one of the balancing planes is greater than on the other, as in any of the instances you have heretofore named, and you are holding on to the rudder wheel so as not to lose your control over the horizontal rudder, is not the rear vertical rudder either at such time held in a fixed position, or turned to one side?

A. It is necessary for me to explain at this point that the control post of this machine moves in a forward and backward direction with reference to

the middle point of the machine, and the moving 169
of this steering post forward and backward controls the elevating and the depressing of the machine. On the other hand, a movement in an entirely different plane and a movement consisting of rotating a wheel in a plane at right angles to the movement forward and backward of the control post, is used to move the rear vertical rudder used for steering in the horizontal plane, and it is perfectly possible to loosely hold this apparatus in such a manner that it may be moved forward and backward without in any way affecting the rotation of the wheel, or the turning or holding in a
fixed position the rear vertical rudder, and it is 170
also possible, as I have before stated, to hold the control post itself and operate the horizontal controlling surface, without operating the rear vertical rudder, and my reference to moving the horizontal controlling surface was intended to convey clearly that any such action would not in any way affect the operation of the rear vertical rudder.

Adjourned at 4:30 to Sept. 12, at 10:30 A. M.

New York, N. Y., Sept. 12, 1911,
10:30 A. M. 171

Met pursuant to adjournment.

Present—Counsel as before.

XQ106. In steering the defendants' machine which you have flown, do you not sometimes turn the rear vertical rudder toward the side of the machine where the balancing plane has the less angle?

A. The rear vertical rudder can be turned in

172 either direction, and the balancing planes can be operated by the aviator leaning to one side or to the other. As to what the effect of the operations would be depends upon the circumstances existing at such a time and the conditions obtaining, and the movements so made bear absolutely no relation to each other, and you do not make one movement because you make the other movement, nor vice versa. You can make either movement which you desire, but in straight-away flight you do not move the rudder when the balancing planes are used.

XQ107. Your answer does not apply to the question. The last sentence of your answer limits the
173 non-use of the rudder to straight-away flights. My question included any kind of flight or direction. So explained, please answer.

A. In curved flights the rudder may be in a turned position while the operation of the balancing planes takes place, but you do not turn the rudder for any other purpose than for steering the machine and directing its course.

XQ108. Then if you were flying in a curve, with the right-hand balancing plane having the less angle, and you desired to turn to the right, you would turn the rudder so that it would swing to the right, would you not?

174 A. This question assumes that the machine is in a banked position or a position off of the horizontal. Am I correct in my assumption?

XQ109. Yes, the lateral inclination of the machine might be more or less, and you may answer the last question with that understanding

A. It is necessary for us to understand at this point that when the machine is banked or is flying at an inclination to one side or the other, that is, as if it were flying around the interior of a saucer or a bowl, that the turning of the machine can be and is sometimes accomplished by the moving of

what in horizontal flight is used to govern up and 175
down direction. In other words, in flying when the machine is at an inclination, the operation of the front control or elevating and depressing surfaces of the machine serves in a measure to direct its course with reference to its direction over the surface of the ground, and therefore if it were desired to turn the machine in some such manner as the question has indicated, it would be necessary to consider the conditions and to see if the front control would be used for accomplishing the desired effect. Therefore I cannot answer the question as to whether I would turn the rudder as requested. 176

XQ110. You must know that the use of the horizontal rudder in the manner stated in your last answer, would not bring the machine out of the curved course and is a mere freak use of the horizontal rudder, and not the normal way in which to turn the machine to the right under the conditions in my preceding question. I think you owe it to yourself, as well as to complainant and the Court, to answer that question squarely.

> Counsel for defendants objects to the unwarranted assumption in the question. XQ108 distinctly states that "you were fly- 177
> ing in a curve," and that "you desired to turn to the right." Nothing was said about it being desired to "bring the machine out of the curved course."

A. I have operated the machine on a curved course, I have operated the machine when it had a very considerable banking effect, that is, when the machine was flying at a lateral angle, and I know what the results are from the operation of the various controls. I know what to do under

178 circumstances to produce the desired effect, and I speak from my personal experience and from the actual operation of the machine under such conditions as are stated. I will also ask that you kindly consider this machine to be flying at an angle of 90 degrees from its ordinary method of flight, and you will clearly see that the front control in this condition becomes a rudder or vertical surface, and what was formerly the rudder now becomes a horizontal surface and would perform the ordinary function attributed to the horizontal control, namely, of elevating or depressing the machine with respect to the surface of the earth. You can
179 readily see therefore that in dealing, as we are, with matters requiring the consideration of three dimensions the machine is rotated back to its normal horizontal position of flight, the controls in a varying degree resume their effect and action which they offer when the machine is in a horizontal position, and I think that if this situation is clearly realized, that my answer to the above question, especially as is indicated by my request to know if the machine was in a "banked position or a position off the horizontal," shows that I had in view the condition above stated and gives an answer squarely and fairly as is desired and which I think the
180 Court will understand.

XQ111. As I had asked you with reference to the operation of the rear vertical rudder in XQ108, under the circumstances stated, and as you have made no reference to the use of the vertical rudder under those circumstances, you have not answered the question. I will now ask you another question before going back to the subject-matter in XQ108. Do you mean by your two preceding answers, or either of them, that you personally have used a horizontal rudder in the machine you

have flown to change the course of the machine, 181
while circling, from a left-hand to a right-hand direction so that the machine would travel off to the right and curve in that direction?

A. If you will kindly refer to the latter part of my answer to XQ109, you will find there my answer to XQ108, and it says "Therefore I cannot answer the question as to whether I would turn the rudder as requested." This is a reference to the rudder which I assumed was referred to in the question XQ108 and which I am advised was not referred to by me and the first part of the present question XQ111 states that I have made no reference to,
and I assume that the rudder referred to means the 182
rear vertical rudder.

It is necessary for me to make my statement a little clearer and I think that what I said limits any action which may be the result of a movement of the horizontal rudder to such a time as the machine may be banked or flying at an angle, and not horizontal. Therefore its operation would be limited to varying the course of the machine with reference to the ground while inclined to one side or the other. When the machine flies horizontally, as I would assume it would be necessary to do while the machine is changing from a left-hand circle to a
right-hand circle, as the question indicates, as my 183
statement shows at this period of a flight, the rear vertical rudder in its ordinary capacity would have to be used for a change of direction at this time. While the machine has been banked to one side or the other, I have used personally the horizontal rudder and it has changed the course of the machine in reference to its direction over the ground, but while the machine is flying horizontally, I have not used the front control or horizontal rudder for this purpose, namely, circling over the ground

184 or changing from a left-hand circle to a right-hand circle, as I understand the question as asked?

XQ112. Then if at any time you were flying in a straight-away course and wished to turn off toward the right, and at such time the right-hand balancing plane was at a less angle than the left-hand plane, you would turn the rear vertical rudder so that it would swing over to the right, would you not?

A. In what position is the machine flying in your question?

XQ113. The question indicates a straight-away course.

185

> By Counsel for Defendants: Is the machine banked, or flying horizontal?
>
> By Mr. Toulmin: Not recognizing the right of opposing counsel to interrogate me while I am cross examining his witness, I would state for the witness himself that the machine under my question XQ112 is not banked as in making curves.

A. In the practical operation of a Curtiss machine, when the balancing planes are turned the machine changes its position, and if the left-hand balancing plane was at a lifting angle and the
186 right-hand plane at a depressing angle, the machine would not fly horizontal, and in this case would bank up on the left-hand side, and does bank up on the left-hand side, which would cause the machine to proceed out of a straight line toward the right, as in circling a saucer-shaped track, and the rear vertical rudder would not be moved to accomplish a turn from the straight-away course.

XQ114. As the flights in the alleged tests referred to in your answer 5, made at Hammondsport, were all straight-away flights, why was not the rear vertical rudder removed from the machine

and the tests made without the rudder being on the 187
machine?

A. The tests at that time were made "to see if the use of the side balancing planes in the machine which were made by the Herring-Curtiss Company would or would not deflect the machine out of the straight course ahead while in flight, and whether or not it was necessary to use the rear vertical rudder to counteract any such turning tendency." It was found upon that occasion conclusively that it was not necessary to operate the rudder and that the operation of the balancing planes in no manner or way deflected or swerved the machine, and the ob-
ject of these tests being to determine this point 188
of fact, namely, as to whether the rear vertical rudder must be turned or is turned at any or such times as the operation of the balancing planes takes place, or in any manner whatsoever to effect their use or contribute to their effectiveness or their ability to maintain the lateral equilibrium of the machine, and this object having been satisfactorily attained, tests such as indicated by the question were not made, and I cannot state any further reasons other than that the object of the experiments as stated was accomplished.

XQ115. If these tests showed that the rear ver-
tical rudder was not needed in regaining lateral 189
balance, why did you not seal the rear vertical rudder when you mounted the machine for a straight-away flight at that time, and after Mr. Curtiss had made the tests referred to?

A. By reference to my answer to Q5, "In these flights the steering wheel was not sealed as I had not previously flown a machine of this type. In these flights I lost and regained the equilibrium of the machine in both directions by the use of the balancing planes, and I positively state

190 that I could detect no swerving or turning of the machine at any time such balancing was accomplished, nor did I move the vertical rudder in any way when balancing." All the operators of Curtiss machines have learned by getting into a single machine and have flown without instruction while in the air and on account of the naturalness and comparative simplicity of the movements necessary to operate this machine under suitable conditions of the air, this is possible. A movement of one of the controls is followed by a definite result and a perfectly natural one. After conducting the elaborate tests
191 during which Mr. Curtiss operated the machine and I observed carefully its action, I did not deem it necessary for me to seal the steering wheel under the conditions as stated in my answer to Q5.

XQ116. Is it not the fact that you did not seal the rudder because you were afraid you might need to manipulate the rudder in those tests and you could not do so if you sealed it at least without breaking the seal?

A. I do not know that my state of mind has to do with this question of fact, and I stated
192 that I thought it conclusively proved by the tests which Mr. Curtiss made and the personal experience which I had at that time.

XQ117. Is it not a fact that in steering a flying machine such as you have flown around curves, the operator from moment to moment readjusts his steering devices different amounts according as he finds the machine circling too fast or too slow?

By Mr. Newell: What "steering devices" do you refer to? The rear vertical rudder?

By Mr. Toulmin: The question of counsel is ignored for obvious reasons. 193

By Mr. Newell: In view of the statement by complainants' counsel the witness is instructed that he may explain in his answer just what steering device or devices he, the witness, refers to in giving his answer, as the question is ambiguous and, in view of the refusal of counsel to make it clear, seems to have been framed with that object in view.

By Mr. Toulmin: Counsel for complainant protests against this interference with the cross examination under the pretense 194 that the questions are ambiguous; also to this method of instructing the witness as to what he shall embody in his answer before the witness is given an opportunity to answer the question, but if it be true that the witness does not know what devices in the machine he has flown the "steering devices," then he has not been competent to testify on the operation of that machine.

A. In the question as asked, do you mean by "circling too fast or too slow," making a circle 195 too large or too small, or of greater radius or less radius?

XQ118. I mean making a circle too large or too small?

A. In such case I think that a variation in the speed of the machine which can be controlled to some extent in the machine about which we are talking, would make a difference in the circular path which the machine was making, and it might not be necessary to "readjust his

196 steering devices" different amounts as assumed in the conditions of the question as stated.

XQ119. You may answer the last question with the understanding that the speed of the machine was substantially uniform during this circling operation.

A. I think that in the case of a perfect turn, that is, with all conditions favorable, that the machine could turn provided the proper adjustment were made without requiring substantial readjustment, and if the conditions were absolutely ideal, without readjustment. Under practical conditions and in my experience in flight, both
197 operating a machine and flying as a passenger, I have observed long circles to have been made with the controls of the machine practically unchanged, and not readjusted from moment to moment as the question would seem to imply.

XQ120. But my question distinctly states that the condition was such that the machine was "circling too fast or too slow." Observe this and now answer the question.

A. Your question says, "according as he finds the machine circling too fast or too slow." If the machine is not flying according to the desires
198 of the operator, he can change the action of the machine in any way that he desires, whether it be by the use of one method or another, but it is not necessary under conditions which I have stated and which I understood was the meaning of the question for "the operator from moment to moment" to "readjust his steering devices."

Adjourned at 1:10 for lunch.

Testimony resumed at 3 P. M. 199

XQ121. During the few times you have flown the defendants' machine, have you turned the rear vertical rudder toward the side having the balancing plane with the less angle so far as you now remember?

A. The balancing planes and the rear rudder may have been in such a position as you indicate by your question during the times that I have flown the machine.

XQ122. Have you ever noticed that during circling the inner wing or side of defendants' machine has slower speed than the outside wing or tip, and 200 as a result that the inside tends to sink and would sink too low unless the balancing planes are held out of the neutral position?

A. In circling there is a natural bank for the machine to take and such a course that the varying forces may be so balanced that the machine will follow the turn without losing its equilibrium, and if the question will state in respect to what the wing or side of defendants' machine has slower speed than the outside wing or tip, it will assist in the forming of my answer.

XQ123. The last question distinctly assumes or states that the inner wing is traveling slower than 201 the outer wing. So what you ask is already stated. You will therefore please now answer the last question.

A. If you mean by your question that the machine is out of equilibrium, equilibrium can be restored to the machine even if the balancing planes are held in the neutral position.

XQ124. The question is clear enough to one who understands the operation of defendants' machine, and unless you give a specific answer I shall conclude that you either do not know what the fact

202 is, or are unwilling to make a direct statement. You continually resort to counter questions on the simplest matters inquired about, and the Court had as well at this point have its attention called to your methods. I accordingly ask you once more to kindly answer, one way or the other, XQ122.

By Mr. Newell: Counsel for defendants objects to the unwarranted statements in the question. The witness is apparently trying to give a full and complete answer.

A. The question as asked assumes something to be so, that may not be so, and if the question means
203 that the machine during circling loses its equilibrium, equilibrium may be restored by a change in the direction of the machine, and the question seems to me to limit the restoration of equilibrium to action by the balancing planes. I have noticed the machine referred to in many different positions and circumstances, and I cannot tell whether it has been in the exact set of conditions which you have stated as far as my understanding of them goes.

XQ125. When you say that you have never moved the vertical rudder to compensate differences in the resistance of the balancing planes, you really mean that the movements you do make of such
204 rudder are made for the purpose of correcting deviations due, in your opinion, to other obscure causes. Is that correct?

A. I move the rudder for steering the machine and directing its course, and I use it independently.

XQ126. Is that the best answer you care to make to the last question?

A. I tell you what I do with the rudder while in the machine and what I use the rudder for, and I use it for the direction of the machine independently.

XQ127. In attempting to fly that machine to a fixed point in a distance, does not the machine almost constantly tend to deviate from a straight course? 205

A. There are causes in the air which serve to move the machine in accordance with their action, and the machine may be deviated by outside influences. The machine steers very readily and maintains its course in flight, and it is not necessary to constantly move the rear vertical rudder to which I assume you refer, or the other controls of the machine, except as these varying outside conditions arise.

XQ128. Does that machine generally tend to lose its straight-away course when and at the time it loses lateral balance? 206

A. The tests which were made to determine this point clearly show that this was not the case, and referred to in my answer to Q5.

XQ129. Your last answer refers to the time when lateral balance is being recovered, in accordance with your claim of the method of recovering. My question refers to an earlier period, namely, to and during the period when the machine is losing its lateral balance and before the correcting means are utilized. I therefore again ask the same question.

A. I would like to refer to the test made upon this very point, and in my answer to Q5 it distinctly states "Mr. Curtiss in this flight did lose and regain the machine's equilibrium." "I distinctly observed that the machine did not turn or swerve out of its course when the balancing was done," and again upon another occasion "Mr. Curtiss lost and regained the lateral equilibrium of the machine." "I distinctly observed that the machine was not deflected out of its course by such use of the balancing planes at any times when they were operated," and again on another occa- 207

208 sion "I observed him losing and regaining his equilibrium in both directions and using the balancing planes with this exaggerated effect, yet I could detect absolutely no turning tendency given to the machine."

> Counsel for complainant objects to the answer as wholly irresponsive, and in disregard of the caution above given as to the time inquired about when the machine is losing lateral balance.
>
> Defendants' Counsel believes that the witness has answered the question as he un-
> 209 derstands it, and suggests to Counsel for complainant that if the witness has not given a direct answer in his opinion, the question be explained further and the particular "correcting means" defined.

XQ130. I have asked you simply whether or not in that machine it generally tends to turn from its straight-away course when disturbed by some atmospheric condition which causes it to lose its lateral balance. Please answer that question and do not, as you did above, discuss the matter of recovering the lateral balance.

A. My answer stated three specific cases which
210 covered the losing of equilibrium as well as the regaining of it, and the words in the question are "when the machine is losing its lateral balance," and my answer covered that point, which is again asked in XQ128.

> The last objection to the question is repeated to the answer just given.

XQ131. Please give the date by day of month and year and place where you made the flight referred to in your reply to XQ34?

A. The flight referred to occurred at what is

known as Sheepshead Bay track, New York. I 211
do not recollect the exact date. It was in the latter part of July, 1910.

XQ132. Who wrote the affidavit which you embodied in your fifth answer?

A. I wrote the substance of this affidavit myself from field data made at the time.

XQ132a. Who assisted you in the final draft as the same is embodied in the affidavit and the answer?

A. As far as the legal terms and phrases, I would refer you to counsel. As to the answer, I dictated it myself to the Court.

XQ133. In giving your fifth answer you held a 212
copy of the affidavit in your lap and read from it, so that even to the quotations the answer follows the affidavit in all respects where you did not omit the little that you left out of the affidavit in giving the answer? Is that not correct that you read from the affidavit in giving the answer?

A. I conducted the tests, I wrote the substance of the matter which was a full report of the actual things that transpired, and I prepared it in a very full degree. The matter was put into legal form, and the affidavit and the answer express exactly what occurred. I did read this affidavit. It was
my affdavit and expresses fully the conditions 213
and the results obtained, and at the request in Q5 to "describe the experiments made." I did so in the very best way that I could. I am thoroughly conversant with what occurred at that time and desired that the full details should appear.

XQ134. At whose request did you go to Hammondsport and take part in these alleged tests to which the affidavit and answer 5 refer.

A. I went at the request of Mr. Glenn H. Curtiss.

XQ135. And up to that time you had never flown in a Curtiss machine?

214 A. I had never flown in the machine, but I had seen it in operation many times.

XQ136. Did you render that service to Mr. Curtiss for compensation?

A. No, I did not receive compensation for that service.

XQ137. I do not refer to money only. But was it understood that you would be compensated either by the payment of money or otherwise?

A. No, there was nothing said about compensation.

XQ138. And for your services or time in giving this deposition, are you serving with or without
215 compensation?

Objected to as immaterial.

A. There is no arrangement about compensation.

XQ139. Now Mr. Post, is there not an understanding that you are to be paid for your services in connection with this deposition, and any other work you do in connection with this suit?

Same objection.

A. There is no arrangement or understanding about this matter.

216 XQ140. Well, do you say you are not to be paid in any manner hereafter, and have not so far been paid with respect to your services in testifying in this case, and any other work you may do in this suit?

A. There is no arrangement or understanding about this matter. I conducted the tests at Hammondsport, as already stated. I think that answers your question.

XQ141. Well, do you say to the Court that you are not to receive and have not received compensation, in money or otherwise, directly or indirectly, for your services in this case, including this deposition? You will be expected to answer without any mental reservations. 217

A. I have not made any arrangements, or have I any understandings about this matter. I have been interested in the subject of aviation and I am anxious to do all that I can to bring out the facts in this case as I see them.

XQ142. Your expenses were of course paid to Hammondsport while there and returning by Mr. Curtiss or some one in his interests, were they not?

> By Mr. Newell: I do not wish to load the records with objections, but wish it to be understood that I object to this entire line of cross examination as absolutely immaterial. 218

A. My expenses were paid.

XQ143. Were you allowed so much a day for your time?

A. No, there was no allowance.

XQ144. Did you have a contract either with Mr. Curtiss or the Herring-Curtiss Company to fly the defendants' machine as an exhibition aviator?

A. No, I had no contract.

XQ145. Well, you entered upon that undertaking and attempted to do such flying for a while, did you not? 219

A. I flew the machine on several occasions when there was an opportunity for me to do so.

XQ146. For compensation?

A. I received no compensation.

XQ147. Was that because you won no prizes?

A. I never flew for a prize.

XQ148. Did it not turn out that you were not suited to work as an aviator and so have discontinued flying for some time past?

220 A. No; I do not think this is the case. I flew the machine as I had a good deal of experience with it, and I think I understand the machine and the operation of it, and I see no reason why I should not be, and continue to be an aviator if I so desired.

XQ149. In answer to Q9 you say you have made in the neighborhood of 25 short flights, but were unable to tell the duration. Then you add that they averaged about two minutes each. Then is it true that you have been in the air on the machine all-told about fifty minutes?

A. I cannot say what the entire time would be.
221 I made many straight-away flights in the machine, and until I felt I had mastered the machine when flying in a straight course. I then made other flights in the machine, circling in both directions, banking the machine and extending it to the limits of its controls in every direction. I took down and set up the machine and directed its taking down and setting up. I was thoroughly conversant with the motor and its parts. I took the machine to Boston-Harvard Aero Meet and made flights there the length of the field and over such portions of the ground as were suited to the machine which I had, which was one of the four-cylinder Curtiss ma-
222 chines, similar to the one mentioned in this suit. I then took the machine to Chicago, and I flew this machine in many short flights across the field of the Hawthorne Racetrack, and I circled about over the field and at times when there were other machines in the air, and I flew in this machine at Mobile, Alabama, where it was necessary to fly high above trees, fences, roads, wires and other obstructions. I was careful with the operation of the machine, and this was at a time when machines were not as perfect as they are to-day, and this was a low-powered machine and required very delicate

handling and manipulation, on account of its construction. I have been interested in the subject of aeronautics and aviation since their beginnings in this country, and have done all I could through my position as secretary and representative of the Aero Club of America to develop this sport and industry. 223

Session closed at 5:25 P. M.

Adjourned to to-morrow, Sept. 13, at 10:30 A. M.

New York, N. Y., September 13, 1911,

10:30 A. M. 224

Met pursuant to adjournment.

Present—Counsel as before.

Cross Examination Closed.

RDQ150. In flying the defendants' machine and assuming that it has lost its equilibrium. When you desire to restore equilibrium and use the balancing planes for this purpose, will the depressed side of the machine fall behind and sink, or will it retain its position and rise?

A. The depressed side of the machine will not fall behind or sink, but will rise, retaining its position with respect to the other wing. 225

RDQ151. Is the vertical rudder used in any way to aid in accomplishing this which you have just stated?

A. The vertical rudder is not used in any way in accomplishing this manoeuvre.

RDQ152. You mean that it is not moved?

A. I mean that it is not moved.

RDQ153. Is or is not this true whether you are flying on a straight-away course or on a curve?

226 A. This is true both on a straight-away course and on a curve.

RDQ154. In banking up the machine; that is, tilting it preparatory to making a turn to the right, the left-hand balancing plane would be at a lifting angle, and the right-hand balancing plane at a depressing angle. After the desired tilt had been so attained, what would happen if the balancing planes were then brought back to the normal position?

A. The machine would return to normal horizontal flight in a straight direction.

RDQ155. Assuming that the defendants' ma-
227 chine is flying straight-away, and you desire to tilt the machine with the left side raised. You have said that this would be done by depressing the aileron on the left side to give a lifting effect, and raising the aileron on the right side to give a depressing effect. If you desired to take the tilt, but without changing from a straight-away course, would you turn the vertical rudder, and if so, in what direction?

A. I would turn the vertical rudder toward the left-hand high side of the machine and toward the aileron which had the lifting angle. By "and" I mean that is toward the aileron which has the lift-
228 ing angle.

RDQ156. In XQ113 you said that "when the balancing planes are turned the machine changes its position." What did you mean by "changes its position?"

A. I mean by that that the machine tilts.

RDQ157. Even in any case where theoretically there was or might have been a difference of resistance offered by the balancing planes, did or did not any swerving of the machine occur due to the use of the balancing planes, even though the rear rudder was not turned?

A. No swerving of the machine occurred in my 229
experience or observation caused by the use of the balancing planes.

RDQ158. Do you pretend to be an expert on the theory of flying machines as distinguished from your practical experience with them?

A. I do not pretend to be an expert on the theory of flying machines, and my experience has been on the practical side of construction and operation. I am familiar with the air and I have spent over 180 hours in the air and have made upon three occasions trips of nearly two days and nights and have made four trips across this conti-
nent from the Mississippi nearly to the ocean, and 230
have operated all kinds of aerial craft, including balloons, dirigible and flying machines, and have ridden as a passenger in them.

RDQ159. When you say you have made trips of nearly two days and nights and four trips across this continent from the Mississippi, did you mean in aeroplanes or in free balloons?

A. I mean in free balloons and this refers to my experience in the air.

AUGUSTUS POST.

(Deposition of Mr. Post closed.)

231

232 WILBUR WRIGHT, a witness introduced on behalf of the defendants, having been duly sworn, deposes and says:

> Counsel for both parties state that Mr. Wright is produced by agreement between counsel to obviate the necessity of having subpœna served upon him, Mr. Wright having been present with Mr. Toulmin, his counsel, during most of the examination of Mr. Post.

Q1. You are the Wilbur Wright named in the patent in suit?

233 A. I am.

Q2. You are President of The Wright Company, the complainant herein, and have been so since its organization?

A. I am and have been, although I understand that I am now appearing as a witness for the defense.

Q3. Did you on or about September 18, 1901, deliver an address before the Western Society of Engineers in Chicago, a print of which I show you here?

A. I did, to the best of my recollection, though I think the reprint contains a few slight amend-
234 ments.

Q4. Such amendments were made or authorized by you?

A. They were.

> Counsel for defendants herewith introduces said reprint, and requests that it be marked as Defendants' Exhibit "Wright 1901 Address."

Q5. I show you here a letter to the Aero Club of America, which purports to have been written by yourself and your brother, Mr. Orville Wright.

It is printed in the Technical World Magazine for June, 1906. Will you please look at it and state if you and your brother wrote that letter? 235

A. I have never compared the letter as here printed with the original letter, and I cannot state definitely whether it is a correct copy of it, but I notice various parts which I recognize, and if my opinion will be proper I will state that this copy is probably substantially correct.

Q6. To the best of your knowledge and belief, it is correct, is it not?

A. I have not seen the original for a number of years, but as I have already stated I presume that it is substantially correct. 236

Q7. Please read it over and if there is any part of it which you do not believe is correct, state such part?

A. I think the statements contained in this article do not materially vary from the truth.

Q8. I did not mean to ask in regard to the truth of the statements, as you seemed to assume, but only as to the correctness of the reprint as compared with the original. Now having read the letter over, if there is any part of it which you do not believe is a correct copy of the original, please state such part?

A. I do not know whether or not there is any 237
part which is not a correct copy of the original, and therefore am not in a position to express any positive belief further than what I have already said.

Q9. Please state the best of your recollection and belief in regard to the matter?

A. So far as my recollection extends, it is substantially correct.

Q10. Now Mr. Wright, is or is not that copy a correct copy to the best of your knowledge and belief at the present time?

A. I have no knowledge, and my belief would be subject to reservations due to the fact that I can-

238 not at this date remember the exact contents of the original letter.

> The copy of the letter is introduced in evidence and marked as Defendants' Exhibit "Wright Letter to Aero Club."

Q11. You certainly have a belief in regard to the matter, and I will ask you to state your belief without any mental reservations?

A. I have no belief but only presumption of a belief.

Q12. Well please state your presumption of a belief?

239 A. It is my presumption that the copy is substantially correct, as I have already told you.

Q13. That is the best you can answer at the present time?

A. It is.

Q14. I show you here the July, 1901, copy of the Aeronautical Journal, which on pages 47 to 49 contains an article entitled "Angle of Incidence, by Wilbur Wright." Did you write that article?

A. I think so.

Q15. As a matter of fact you did, did you not?

A. I wrote an article and sent it to the editor of this publication, and I presume it was correctly
240 reproduced, although I have not compared the written article with the printed publication.

> Counsel for defendants introduces the article in question, and requests that it be marked as Defendants' Exhibit "Wright Article on Angle of Incidence."

Q16. You have just read over the article, have you not?

A. I have.

Q17. If there is any part of it which is not as

you wrote it (so far as you can remember), please 241
point it out?

A. I do not remember any such part.

Q18. You gave another address before the Western Society of Engineers in 1903, and which address or paper described some experiments in regard to what you and your brother had done in flying machines. Is that correct?

A. That's correct.

Q19. That paper or address was reproduced by the Western Society of Engineers by authorization from you?

A. It was reproduced with a few amendments
by authorization from me. 242

Q20. Such amendments were made by you before its reproduction?

A. They were.

> Counsel for defendants states that he has not a copy of the paper here at hand, but is expecting it to-day and so cannot submit it to Mr. Wright or introduce it at the present time.

Q21. You and your brother began experimenting with gliding machines in the year 1900?

A. Our first attempts to glide in a gliding ma-
chine were in the year 1900. 243

Q22. Was that machine one composed of two superposed supporting surfaces with a horizontal rudder in front, but without any vertical rudder?

> By Mr. Toulmin: The question and any other of like nature is objected to on the ground that the matters inquired about are not in issue in this case; that the date and history of the invention are not involved in any defense set up. The patent itself being the subject matter which is under interpre-

244 tation, and therefore the prior history with the dates and different events is a matter wholly outside. This objection is made once for all, and the witness is advised that it is optional with him to disclose what is called for or may be called for by this line of questions.

A. It was.

Q23. Were those superposed supporting surfaces flat or curved?

A. In what direction? Do you have reference to curvature from side to side or from front to rear?

245 Q24. Please explain as to both.

A. The surfaces of this machine had a very slight curvature from front to rear, and at various times during the experiments of that year were given different slight curvatures from tip to tip, but were usually substantially flat.

Q25. By "from tip to tip" you mean from one lateral margin to the other?

A. Yes, sir, just as I would refer to the wing tips of birds.

Q26. What was the proportion of curvature from front to rear?

A. I have not my notes at hand, but my recollec-
246 tion is that the depth of curvature from front to rear was about one-twentieth of the fore-and-aft dimension, and about one-hundredth of the tip to tip dimension, though it was probably a little greater than this when the machine was first erected, and somewhat less toward the end as the ribs which were bent by steaming gradually lost their curvature as the season advanced.

Q27. In other words, the ribs were bent to the shape you desired when the machine was constructed, and the cloth stretched over such bent ribs. Is that correct?

A. This is substantially correct, so far as the ribs 247
are concerned.

Q28. When you say that the "depth of curvature from front to rear was about one-twentieth of the fore-and-aft dimensions," do you mean one-twentieth of the length measured along the curve, or one-twentieth of the chord of the curve?

A. We usually referred to the chord, though the length along the curve owing to the slightness of the curvature is substantially the same thing.

Q29. Was this curve an arc of a circle?

A. It was not.

Q30. What was it?

A. The rib was straight throughout approxi- 248
mately nine-tenths of its length, and then bent downward slightly. The curvature of the rib itself was approximately one-fortieth of the length of the rib, and about one-two-hundreth of the tip to tip measurement of the surface, but when I refer to the fore-and-aft curvature of the surface, I include the thickness of the front spar in estimating the total curvature as one-twentieth.

Q31. Why did you and your brother use this peculiar curved surface instead of a plane flat surface?

A. We hoped to find it capable of slightly dif-
ferent lifting power than absolutely true planes, 249
as a trifling curvature had been recommended by people who had made laboratory tests of flying surfaces.

Q32. Did you find that such curve gave greater lifting power than flat planes would have done?

A. Our conclusions from that year's experiments led us to believe that they did not have superior lifting powers, though we had never tested absolutely flat planes in a gliding machine.

Q33. Why not?

A. In building our first machine we happened to use 'curves, different students of the theory

250 flights having given contrary opinions as to the advisability of using true planes or planes with but trifling curvature, or planes with slightly deeper curvature. Our surfaces were a compromise.

Q34. So you used curved surfaces merely because you "happened" to do so? Is that really correct?

A. We chose what we thought would be the proper surface to use.

Q35. Then it wasn't a mere accidental choice or happening, but it was because you thought those curved surfaces were considerably better than flat planes. Is that correct?

251 A. We accepted the idea of Lilienthal that a very slight curvature would give results somewhat better in some respects than geometrically true planes, but were careful in following his advice not to part from the plane surface too far. Our surfaces were really flatter than even he recommended it.

Q36. How much greater lifting effect did your curved surfaces give than they would have given if they had been true planes?

A. I have no means of knowing exactly as we have never constructed a flying machine having geometrically true planes to compare it with, but
252 our experiences of that year led us to the belief that there was little or no difference.

Q37. Then your belief at the present time is that there is "little or no difference" between the lift exerted by a plane surface and one having the curvature mentioned?

A. My present belief is that there is some difference.

Q38. About how much at the ordinary angles of incidence at which a flying machine is flown?

A. I have not my note books with me as I had no knowledge of any intention to question me on

such subjects, and I do not remember that I have 253
tested the surface exactly similar in its characteristics to that used in the 1900 gliding machine, but speaking offhand I should say that at zero angle of incidence, the lift of the surfaces used in this machine would be infinitely greater than that of a plane, as the curved surface has a slight lift even at zero, while the plane is supposed to have none. The relative difference decreases rapidly in the angles used in flight and at fifteen degrees would probably have a fourth or fifth more than the true plane, though I am not able to give any very accurate statement without referring to my note books. 254

Q39. According to your recollection, isn't the "fourth or fifth" above mentioned rather smaller than it really is?

A. Since answering the question I have been thinking that probably it is somewhat too great, but in the absence of note books of tests of various surfaces, it is quite impossible to make any very definite estimate.

Q40. What advantage or advantages other than increased lift, does a supporting surface, curved as you have specified you did, possess over a true plane surface, in your opinion?

A. In my opinion in other respects a true plane 255
would possess advantages for flight over any curved surface, but in practice it is impossible to obtain a plane surface which is free from thickness, and with the thicknesses which seem to be necessary in practice, it is believed that imparting a very slight curvature to the surface leaving it substantially flat, increases the lift in greater ratio than it increases the resistance, but if the depth of curvature is seriously increased as some students of aeronautics have recommended, this advantage disappears entirely as compared

Emile or "Kent."

Over

256 with surfaces nearer flat. The substantially flat surfaces are better than the deep curves.

Q41. Who were the "some students of æronautics" above mentioned by you, who recommended deeper curves?

A. Lilienthal, Chanute, Herring, and possibly others.

Adjourned for Recess at 1 P. M.

Resumed at 2 P. M.

Q42. You have spoken of two advantages which
257 your curved supporting surfaces possessed over true planes. Will you name any others which occur to you?

A. I do not now remember any others.

Q43. You are sure about that?

A. I am not sure, I simply state my recollection at the present time.

Q44. I will try to refresh your recollection. What do you now consider the relative advantages of such two surfaces are (when used as supporting surfaces) with relation to the change or shifting of the center of pressure in a fore-and-aft direction due to changes in the angle of incidence?

258 A. On the whole I would prefer, as a matter of relative advantage, that the surfaces should be flat rather than curved, in referring to the travel of the center of pressure.

Q45. The main surporting surfaces on the complainant's machine are curved at the present time, aren't they?

A. They have a slight curvature.

Q46. What is the proportion of the curve, and at what distance from the front edge is the deepest part of the curve?

A. The curvature varies in different machines.

Q47. Why?

A. According to the special use to which 259
the machine is to be put.

Q48. Now, Mr. Wright, isn't it a fact that in all the machines of the complainant at the present time, the main supporting surfaces are curved from front to rear with the deepest part of the curve somewhat in front of the center?

A. The wings or supporting surfaces have a slight curvature from the true plane, and I think the point of deepest curvature is a trifle in front of the center.

Q49. About how much in front of the center?

A. Probably from a sixth to a tenth of the
length of the surface from front to rear. 260

Q50. Why did you curve your main supporting surfaces from tip to tip, that is, from the center downwards toward each lateral margin?

A. We tried them first curved upward, but afterwards tried curving them down in order to compare results.

Q51. Which did you find was the better?

A. That is a question concerning which we have held different opinions at different times. We have changed the position of the tips both ways within the past two years. Each method has
some advantages and some disadvantages, and 261
it is not easy to determine exactly which is best, but we have usually had trouble if we attempted to part seriously from the straight line. Our machines have recently been built straight.

Q52. How recently?

A. Within the last month.

Q53. Prior to that all your machines had a curvature one way or the other from margin to margin. Is that correct?

A. We have been building them this way all of this year, that is, straight.

262 Q54. You mean in the present year, 1911?

A. I do.

Q55. Then, except for the 1911 machines, all your machines had the transverse curve. Is that correct?

A. The machine which I flew up the Hudson River around Grant's tomb during the Hudson-Fulton celebration was straight. Some of the others have been straight, some of them have curved downward an inch or two at the tips, and some have been curved downward and finally upward at the tips. Most of the machines have not varied to more than about one inch from a
263 straight line in either direction, unless by accident.

Q56. In which direction was the 1903 machine curved laterally?

A. It was curved downward slightly at the tips.

Q57. What advantage did you consider at that time such curvature attained?

> By Mr. Toulmin: The Court will note that this line of examination is outside of any matter involved in the patent, or in any issue in this case. This comment and objection is made once for all.
>
> By Mr. Newell: The pertinency of this
> 264 line of examination will be fully set out at the proper time.

A. We thought that it reduced, to some extent, the disturbing effects of lateral windgusts.

Q58. Did you do any gliding in your 1900 machine, that is, I mean free gliding?

> Objection is repeated once for all to this line of questions.

A. We made several semi-free glides. By this I mean that during part of the glide an attendant ran at each wing-tip with his hand on the upright post, but his hand lightly touching, but toward the end the speed of the machine became so great that the attendants could not keep up, and the last fifty or sixty feet of the glide would be entirely free. 265

Q59. Then the free glide was only about fifty or sixty feet?

A. That is correct as regards the year 1900.

Q60. How did you propose to balance the machine, that is, restore lost lateral equilibrium in that machine? Was it by warping the wings?

A. Do you mean during these glides?

A. Yes.

Q61. We did not attempt to restore lost lateral equilibrium in these glides. The glides were made 266
for the purpose of testing the effect of the front horizontal rudder in maintaining fore-and-aft equilibrium.

Q62. Did that machine, that is the 1900 machine, have any provision by which the lateral margins of the wings could be warped

A. It did a part of the time and part of the time it did not. The experiments covered a month or more.

Q63. Did you try to restore lost lateral equilibrium by warping the tips in that year, 1900?

A. Yes, in experiments made with the machine held at a fixed point. 267

Q64. That is, held by a cord like a kite?

A. Yes, with the exception that we usually endeavored to maintain the cord in a horizontal instead of an inclined position so that the cord would have an effect as nearly as possible analogous to that of a screw-propeller.

Q65. If I understand you correctly, in your last few answers, you did not attempt to restore lost lateral equilibrium during the year 1900 when the machine was gliding freely, even though provided

268 with means for warping the tips of the wings. Is that correct?

A. The warping cables were rigidly fastened when these attempts at free flights were made.

Q66. The publication of your address in 1903 and referred to in Q's18 to 20 has just come in by mail. It is entitled "Experiments and Observations in Soaring Flight. By Mr. Wilbur Wright." Will you please look it over and state if you read that paper at Chicago before the Western Society of Engineers in 1903?

A. I read substantially this paper at that time and place, though it may have been revised a little
269 before publication.

Q67. Such revision was made by you, was it not?

A. It was.

> Counsel for defendants herewith introduces such copy and requests that it be marked as Defendants' Exhibit "Wright 1903 Address."

Q68. Now going to the 1901 experiments made by you and your brother. How did that machine differ if at all, from the 1900 machine or machines?

A. The chief difference was in the size.

Q69. What other differences?

270 A. Everything in the machine was more or less different, but there was a general similarity.

Q70. Did it have a vertical rudder which could be moved from side to side when in flight?

A. It did not.

Q71. Did it have a vertical fixed surface in the rear?

A. It did not.

Q72. It had two curved main supporting surfaces and a horizontal front rudder, but no other surfaces. Is that correct?

A. I think so.

Q73. All of the 1901 machines, if there was more than one, were so constructed. Is that correct? 271

A. I am not certain.

Q74. Did any of the machines of 1901 have any vertical surface, either in front or in the rear of the two superposed main supporting surfaces?

A. Just at this moment I would not like to attempt to fix, without considerable thought, the time when the vertical surface was used in our experiments. If you have reference to man-carrying gliders, the machine already referred to is the only one of that year, 1901.

Q75. Then there was only one man-carrying machine in 1901? 272

A. Yes.

Q76. Did that machine of 1901 have any provision by which the margins of the wings could be warped?

A. It had, just as in the machine of the preceding year.

Q77. Did you use more than one machine in 1902? I mean "man-carrying glider?"

A. Only one, I think, of our own. Mr. O. Chanute had two machines of his design sent to our camp to be tested by an employee of his own, and my brother and I helped him to handle the machines while preparing them for trials, but nei- 273
ther of us made flights in them.

Q78. Did your 1902 machine have any vertical surface, I mean a man-carrying glider? If so, please state what it was and where located?

A. It did. It possessed a vertical surface located at the rear.

Q79. Was this vertical surface fixed, or was it movable by the operator during flight?

A. We tried it both ways.

Q80. Which was tried first?

274 By Mr. Toulmin: The witness is advised that he need not answer the above or any other question as to matters not embraced in the patent, as the same is involved in this suit and inquiry beyond that branch of the patent is merely prying into the affairs of the witness to a greater extent than the other irrelevant and immaterial questions embodied in this examination.

Counsel for defendants states that counsel for complainant has just advised Mr. Wright that he is not obliged to answer the question if he does not want to.

275 Counsel for defendants states that he does not intend to pry into any matters unnecessarily or improperly, but this matter is germane to the issues and will be shown to be at the proper time. The objection and instruction to the witness is the usual one interposed when toes are about to be trodden upon. Counsel does not desire to delay this case in any way, but he feels compelled to go on with this line of examination, and will be compelled to certify the record to the court for its instruction of the witness in all such cases as the
276 witness declines to answer what counsel conceives to be proper and legitimate questions.

By Mr. Toulmin: Counsel's own statement shows that the relevancy and propriety of inquiring into a fixed vertical surface is not apparent at this time, because he says he will make it apparent when the time comes. It is quite clear that the Court will require the showing of relevancy before the Court makes any order. It is therefore

> suggested that now is the time to disclose 277
> wherein such matter as is inquired about is pertinent to the case. In the absence of such disclosure now, Mr. Wright is advised to use his own pleasure in the matter of disclosing his affairs.

A. The fixed vane was tried first.

Q81. Did that machine which had the fixed vane at the rear have provision by which the margins of the wings could be warped while the machine was in flight?

A. It did.

Q82. Did you try restoring lateral equilibrium 278
in that machine during free flight?

A. I did.

Q83. How many times did you try this?

A. As I stated at the opening of my testimony, I have no note books with me and cannot state with any degree of accuracy the number of such trials.

Q84. Did you try this in more than one flight with that machine?

A. I did.

Q85. What happened when equilibrium was lost and you tried to regain it by warping the wings
with this machine which had the fixed vane? 279

> Counsel for complainant has concluded that defendants' counsel is undoubtedly prying into the affairs of the witness beyond the issues in the case; at least as it is claimed by defendants that their rear vertical rudder is a movable or pivoted device, inquiry into any experiments by Mr. Wright concerning fixed vanes is outside of the issues made by defendants, and for this reason, and also because counsel has not disclosed the relevancy of the present inquiry,

280 Mr. Wright is advised not to answer the last question or any other concerning the experiments with fixed vane, until such time as the Court shall otherwise order.

A. By advice of counsel I refuse to answer.

Counsel for defendants gives notice that he will ask the Notary to certify the record to the Court in order that it may pass upon the question whether or not the witness should answer this question, as well as any other questions which he may decline to answer.

281 By Mr. Toulmin: Counsel for complainant gives notice that at such time as the above matter may be presented to the Court, he will also reserve the right to ask the Court to go further and sustain the objection appearing in this deposition, in order to completely protect complainant from this unlawful inquiry into the affairs of the witness.

Q86. Mr. Wright, I desire to ascertain what happened in that machine when you attempted to restore equilibrium, as the question of restoration of equilibrium is a rather important feature of this
282 case. I do not desire to delay this matter and the hearing of the case, but if you decline to answer these questions which I consider are eminently proper, it will cause considerable delay, I fear, and I propose to go on and ask further questions along this line. In view of the foregoing, I will ask you again to answer the question. Please do so.

The advice is repeated (by Mr. Toulmin), with the suggestion that if counsel has not wanted to delay the case, he has had ever since last February to examine one or the other of the Wright brothers on this subject,

if he thought he had a right to, without wait- 283
ing for the experiments to be made by Mr.
Curtiss which he stated was the cause of
his not being able to take his testimony here-
tofore.

By Mr. Newell: Complainant I believe took more than twice the time to put in its *prima facie* case as has elapsed since the *prima facie* was closed.

By Mr. Toulmin: The above statement is a clear error counting from the time the Court of Appeals rendered its decision.

By Mr. Newell: But that is not the way
the times for taking testimony are reckoned. 284
The answer was filed in October, 1909, I believe, and the replication shortly thereafter, if I recollect correctly. The Court of Appeals' decision on the motion for preliminary injunction was handed down July 1, 1910. Complainant did not start its *prima facie* case until the latter part of January, 1911.

By Mr. Toulmin: All of which is of no consequence as the time complainant took for its *prima facie* was with the consent of opposing counsel who signed the stipulation covering the time.

A. I follow the advice of counsel, and refuse to 285
answer at this time.

Q87. Have you any objection personally to answering, or do you refuse merely because Mr. Toulmin, your counsel, has advised you not to answer?

A. I have no personal objection outside of the fact that I consider the experiments referred to, of a more or less private nature, and this question does not appear to have reference to combination

286 or combinations set forth in the claim of the patent sued upon.

Adjourned at 4:30 P. M. to meet at 10:30 A. M. to-morrow, Sept. 14, at same place.

New York, N. Y., Sept. 14, 1911.
10:30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

By Mr. Toulmin: Since the adjournment of yesterday, I have looked into the record
287 made before Judge Hazel on the motion which resulted in a preliminary injunction. I find an affidavit by Messrs. Orville & Wilbur Wright commencing at page 421 of the Court of Appeals record, in which the action of these machines with no vertical tail or vane, with a fixed vertical tail or vane, and with an adjustable vertical tail or vane, was explained to the Court. In view of this the advice given the witness yesterday is withdrawn and the examination may proceed subject to the objection of immateriality and irrelevancy.

288 Q88. What did you mean by the last half of your last answer?

A. I meant that at first thought there might be some question as to whether counsel for defendants' question was pertinent to the question at issue.

Q89. Then you now think it is, after having talked it over with Mr. Toulmin?

A. I advised Mr. Toulmin that after further consideration I thought it might be pertinent.

Q90. Then if I understand you correctly, in 1902

Mr. Chanute had two machines of his own design 289
sent to your camp. These machines of Mr. Chanute's had two curved superposed main supporting surfaces and a vertical tail in the rear. Is that correct?

A. It is not correct.

Q91. What did they have?

A. Both the machines possessed three superposed planes incapable of being adjusted to different angles of incidence at the lateral margins, and a vertical vane or tail incapable of being moved by the operator.

Q92. Did they have any other surface than
those you have mentioned. If so, what? 290

A. My recollection is that both had a fixed horizontal vane or tail in the rear.

Q93. Did you see either of those Chanute machines glide in 1902?

A. I saw them glide a distance varying from fifteen feet to about fifty feet, to the best of my remembrance.

Q94. Did you try gliding in any of them?

A. I did not.

Q95. Who operated them. Please give his name.

A. Mr. A. M. Herring, an employee of Mr. Chanute's.

Q96. Was fifty feet the longest distance you 291
saw either of those machines glide?

A. My remembrance is that I stepped off the longest flight and found it to be about forty-five feet.

Q97. You mean the longest glide that you saw?

A. I saw all the trials which were made.

Q98. Was either of those machines tried with only two superposed surfaces? That is, otherwise the same?

A. I think that after having tried what Mr. Chanute called the "multiple Wing" machine and hav-

292 ing failed to obtain glides of more than about fifteen feet, that the lower tier of wings or supporting surfaces was removed, but the results were not improved.

Q99. Do you state that fifty feet was the longest distance you personally saw the machine glide after the lower supporting surface had been removed?

A. It never glided fifty feet in my sight or presence. I think the longest distance did not exceed six yards with this machine.

Q100. Then you think that the machines of Mr. Chanute aided you in arriving at the proper
293 construction of your own machine?

A. What machines do you refer to?

Q101. I mean the machines which Mr. Chanute you say, had sent to your camp.

A. They did not. Our patterns and designs were already fixed.

Q102. How did these Chanute machines compare with yours in efficiency, in your opinion?

A. What do you mean by "efficiency?"

Q103. Ability to fly.

A. After seeing our machine fly, Mr. Chanute said that he had changed the opinion he formerly held, that the problems of equilibrium had not been
294 sufficiently solved to justify the attempt to build a motor-driven machine and that he advised us to try a motor-flyer. This opinion accorded with our own views.

> Counsel for defendants objects to the answer as irresponsive, as he did not call for any one's opinion except that of the witness.

Q104. Now will you kindly answer Q102.

A. I have stated my opinion, I think, in regard to the relative abilities to fly of our machine, as

compared with those of Mr. Chanute, but if my 295
answer is not clear I may state my honest opinion that I think ours was so different from the others as to put it in a different class, to use a common expression.

Q105. You have said that the machine of your own construction which had the fixed vertical vane in the rear was tried before you tried putting a movable vertical rudder on it. Did that machine of yours having the fixed vertical vane have a single vane or more than one at the rear?

A. It had a pair of vertical vanes.

Q106. Both of them were fixed?

A. They were both fixed. 296

Q107. What result did you observe in this machine with the fixed vertical vanes, when lateral equilibrium was lost in gliding?

A. We observed that sometimes the equilibrium was regained and sometimes it was not.

Q108. So equilibrium was sometimes regained by warping the wings of that machine which had the fixed vertical vane. Is that correct?

A. Do you mean that equilibrium was regained by the warping of the wings alone, without any assistance from any other part?

Q109. Well, when equilibrium was lost in that
machine, was it sometimes regained when the 297
wings were warped?

A. The equilibrium was sometimes regained while the wings were in a warped position.

Q110. Then your answer is substantially yes?

A. I think my answer is entirely clear.

Q111. I, however, do not think so. Will you please see if you cannot make your answer a little clearer.

A. If you will explain in what respect the answer is not clear to you, I will endeavor to make the point clearer.

298 Q112. I do not understand exactly what you mean by "in a warped position." Do you mean that after equilibrium was lost the operator was sometimes enabled to regain equilibrium by warping the wings by turning the depressed margin to a greater angle of incidence and the elevated margin to a lesser angle of incidence?

A. By "in a warped position" I mean with the wings having one lateral margin set at a different angle from the one on the opposite side so as to give this particular machine a more or less windmill effect.

Q113. Now, please answer my last question.

299 A. I explained what I meant by "in a warped position" in answer to Q109, and I understood that you wished this point clearer and I have attempted to do so.

Q114. Well, in that machine of yours with the fixed vanes in the rear, could or could not equilibrium be restored by warping the wings and without doing anything else?

A. The warping of the wings did not in itself restore the equilibrium of the machine. It was merely a means or step in enabling the wind to create pressures on the machine, which would force it back to the normal position.

300 Q115. What else had to be done to restore equilibrium, besides warping the wings, in that machine?

A. It was necessary to bring about an increased pressure on the low wing and a pressure on the side of the vertical vane, which was toward the side of the machine having the smaller angle of incidence, just as in the case at Hammondsport referred to by Mr. Post in his deposition. I do not mean that the vane was moved with reference to the machine itself, but only with reference to the relative wind, all of which was accomplished by

the movement of the cradle which adjusted the 301
wing tips.

Q116. I asked you only in regard to your own machine. Am I correct in understanding that you mean that in your machine we are talking about, the vanes were not moved relative to the machine itself, but that the turning of the machine caused the vanes to swing around and so receive a pressure on the side you have mentioned?

A. The vanes were not moved relative to the machine itself, but they tended to prevent turning of the machine in part, the pressure increasing as the machine overcame the resistance until further turning was prevented by the re- 302
sulting increased pressure, due to turning.

Q117. In other words, the machine swung around when the tips were warped, and this of course carried the fixed vane around causing a pressure thereon due to the skidding of the machine off toward the outside of the curve. Is that correct?

A. That was the theory of the machine.

Q118. And this was always successful in restoring equilibrium?

A. Not always.

Q119. You were, however, sometimes able to 303
restore equilibrium by this means?

A. We were, so far as we could see, and certainly sometimes restored the equilibrium of this machine.

Q120. You were able to restore equilibrium of this machine ordinarily, but sometimes did not restore equilibrium. Is that correct?

A. Without referring to my note book, I could not state definitely the relative number of the flights which ended successfully and those which ended in failure, but I should judge the relative numbers to be about equal, the ratio

304 varying somewhat with the condition of the weather.

Q121. What happened in the flights which you failed to restore the equilibrium in this way?

A. The machine stuck one wing in the ground and dug a hole in the sand. We referred to these landings as "well-digging." That was the nickname we gave them.

Q122. In other words, the low wing failed to rise. Is that correct?

A. We sometimes had this experience.

Q123. You have spoken of a cradle as used on this machine. This was a laterally movable
305 cradle in which the operator lay and which was moved in one direction or the other, that is, toward one margin of the wing or the other margin when the operator moved his body, and which caused the wing-warping wires or cables to be moved. Is that correct?

A. I think it is correct. This cradle was similar to those described in the patent in suit and in the description of the defendants' machine.

> Counsel for defendants does not desire to load the record with objections, but objects to volunteered answers and desires
> 306 that this objection be understood as taken even though not put down after every volunteered answer, or a portion thereof.

Q124. In attempting to restore equilibrium in this 1902 machine we are talking about, the operator of the machine moved his body toward the high side which carried along the cradle with him, causing the margin on the depressed side to be warped down to a greater angle of incidence, and the other margin to be warped

upwardly to a lesser angle of incidence than 307
before. Is that correct?

A. I think such is substantially correct, at least insofar as the direction of motion is concerned.

Q125. Well, does it state the fact or not?

A. Do you wish me to go into the theory of the machine?

Q126. No, I merely wish you to answer the question, for you have only answered a part of it.

A. The motion of the operator's body carried the cradle along and warped the wing downward on
one side and upward on the other. 308

Q127. Now, please read over Q124 and answer it all. If there is any part of it that does not state the fact, please specify it.

A. The angle of incidence is a matter which has some relation to theory, and I would be willing as an expert to express my opinion and belief in regard to it, if you wish it.

Q128. I will try to put my question so that you need not evade it.

In attempting to restore equilibrium in this 1902 machine we are talking about (having the
fixed vanes in the rear), the operator of the 309
machine moved his body toward the high side and carried along the cradle with him, causing the margin on the depressed side to be warped down and the other margin to be warped up. Is that correct?

By Mr. Toulmin: The suggestion of evasion is absurd. A more candid set of answers could not be given as those Mr. Wright has been making.

310 A. As I understand the question it is substantially correct.

Q129. Why did this machine swerve off toward the depressed side when the surfaces were warped?

A. Have I stated that it did?

Q130. Well, did it?

A. It did sometimes.

Q131. Did it always do so when the operator warped the surfaces in restoring equilibrium, or attempted to do so?

A. Before stating that it always did so, I will have to inquire just what you mean by "swerve off," as to whether it refers to deviation
311 from the line of flight, or merely rotation about a vertical axis?

Q132. Rotation about a vertical axis while moving forward is what I meant. Please answer the question with that understanding.

A. If the machine was given a greater angle on the depressed side, it did always, so far as I now remember, start to rotate around a vertical axis, though in making this answer I do not have in mind every individual occasion which after a lapse of nine years have more or less become consolidated in my recollection and
312 I speak rather of the general results and conclusions which we arrived at, as the result of these experiments.

Q133. What was the usual angle of incidence on the main supporting surfaces at which this machine flew with an operator upon it?

A. It varied from about one degree to fifteen or twenty degrees, according to the speed in which the machine moved.

Q134. Did you consider that this machine was a practically successful gliding machine?

A. The expression "practically successful" is

one to which a wide range of meanings might be 313
assigned by different persons, but in view of the numerous accidents in the nature of bad landings from which we are very glad to escape with our lives sometimes, we were not satisfied with it and felt that immediate improvement was needed.

Recess for Lunch at 1 P. M.

Resumed at 2 P. M.

Q135. You have said that of your two 1902 machines, the first one you tried was the one hav- 314
ing the fixed vertical vanes in the rear. Did you put on a movable vertical rudder during that year, and if so, when?

A. Will you please refer to the answer in which I stated that we had two machines in 1902?

Q136. Well, I was under the impression you had so stated. If you did not, please say so.

A. We had but one machine in 1902, but we tried several modifications of detail in it.

Q137. Did you put a vertical rudder which could be moved from side to side on any machine
in 1902? 315

A. We decided to make the vertical vane movable with reference to the body of the machine, and in carrying out this modification we found it convenient to substitute a single vertical surface for the two surfaces previously employed.

Q138. Perhaps you do not get my meaning. Did you in 1902 actually put on to a man-carrying machine, a vertical rudder which could be moved by the operator when in flight?

316 A. We did in 1902 actually put on to a man-carrying machine for the first time in the history of the world a vertical rear surface which could be moved on a vertical axis when in flight.

Q139. And was this movable vertical surface when first put on moved by the operator while in flight?

A. It was moved while in flight for the first time in the history of the world, so far as I am aware.

Q140. Please describe where is was located and just how it was connected up, and how it was moved while in flight?

317 A. It was located and connected up and moved in the manner described in the patent in suit, I believe.

Q141. That is, its operating cables or wires were connected up to the wing-warping cables or wires so that the rudder was moved whenever the wings were warped?

A. I think that is correct.

Q142. You say that this was put on to the machine in 1902. Was it tried in free flight in that year?

A. It was put onto the 1902 machine and
318 tried in that year.

Q143. That is in 1902?

A. Yes, it was tried in 1902.

Q144. Did you make any experiments by actually gliding in the year 1903, previous to the time that you applied for the patent in suit?

A. We did not.

Q145. Did you in 1902 have more than one machine on which free glides were made and which had a vertical rudder which could be moved while in flight?

316 A. We did in 1902 actually put on to a man-carrying machine for the first time in the history of the world a vertical rear surface which could be moved on a vertical axis when in flight.

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Q141. That is, its operating cables or wires were connected up to the wing-warping cables or wires so that the rudder was moved whenever the wings were warped?

A. I think that is correct.

Q142. You say that this was put on to the machine in 1902. Was it tried in free flight in that year?

A. It was put onto the 1902 machine and
318 tried in that year.

Q143. That is in 1902?

A. Yes, it was tried in 1902.

Q144. Did you make any experiments by actually gliding in the year 1903, previous to the time that you applied for the patent in suit?

A. We did not.

Q145. Did you in 1902 have more than one machine on which free glides were made and which had a vertical rudder which could be moved while in flight?

322 Q150. Now Mr. Wright, please state your best recollection as to whether any one, other than yourself and your brother, in the year 1902 had a machine having a movable vertical rear rudder. Please make your answer as direct as possible.

A. I do not remember any case in which a vertical movable rear surface possessed the functions of a rudder in a flying machine.

Q151. You qualify your answer beyond my question. By using the words "possessed the functions of a rudder." What other person, to the best of your recollection, in 1902, had a flying machine which had a movable vertical rear surface?

323 A. Please define the expression "flying machine."

Q152. A machine constructed for the purpose of flying, whether it actually flew or not.

A. And by the expression "a movable rear vertical surface," do you mean a surface which might have been moved regardless of whether it was moved or not?

Q153. I don't care whether it was actually moved or not. I use the word "movable" in the sense of having capability of movement. Are there any other questions you would like to ask before you answer Q151?

A. Yes, I would like to inquire whether you de-
324 sire to impute any particular function to the movement of this vertical vane?

Q154. I do not desire to impute any function to it other than its capability of movement. Any other questions?

A. Do you mean movement on its own axis?

Q155. I mean movement in any way.

A. The machines of Mr. Chanute had vertical vanes at the rear, which could be moved through the air or about the shop, but I think you must have reference to movements about a vertical axis. These machines could be carried about.

Q156. Do you think that is a responsive answer, 325
and why do you try to evade the question?

> By Mr. Toulmin: The record shows no attempts to avade but to explain a condition left uncertain by the question.

A. As you have implied other movements than those about a vertical axis, I must know what you mean before I can answer your original question. I am merely preparing to give you the best answer in my power.

Q157. Very well. That is what I desire. Will you now please read over Q151 and answer it as fully
as you can, describing what such machine or ma- 326
chines were, and who, if any one, had it or them?

A. Taking under consideration the explanations made in Q152, 153, 154, but construing Q155 as excluding such movements as are referred to in answer to Q155, I will say that I do not now remember any such machine. My recollection is that my brother and myself were almost the only people in the world who had not given up the flying problem at that time. If any machines which may have been in existence at that time possessed such movable vertical rear surface, I do not now remember them. I am quite certain that no functional use of any
such surfaces was made. 327

Q158. I don't seem to be able to get what I consider is a really responsive answer to Q151. In your answer just given, you exclude, apparently, all movements referred to in the answer to Q155. One of the movements referred to in that answer is, in your words, "about a vertical axis." Obviously I do not wish to exclude that movement, and I had hoped that you would not insert such exceptions.

Please state whether or not, to the best of your recollection, any one, other than yourself and your brother, in the year 1902, had a flying machine (whether it actually flew or not) and which had a

328 vertical rear surface which was movable in any way relatively to the machine itself?

A. In making my answer to Q157 I meant to exclude only such movements as are referred to in the first and second lines of the answer to Q155. I meant to include all movements relatively to the machine itself.

Q159. You know that prior to 1902 other persons had proposed the use of a rear vertical rudder on a heavier-than-air machine, do you not?

A. Are you referring to speculative machines, or to machines actually constructed?

Q160. Please answer as to both.

329

By Mr. Toulmin: Objected to as immaterial because, whatever be the fact, a so-called rear vertical rudder *per se* is not involved in any claims sued on. This objection is made once for all.

A. So far as I remember, all the experimental machines which rose into the air at any time possessed fixed vertical rudders. I have never been accustomed to pay much attention to speculations. I refer of course to public machines, that is, machines publicly used or publicly described prior to that time.

330 Q161. I did not so limit my question. Please answer it without inserting limitations not expressed in the question.

A. Proposals had been made in regard to the construction of machines intended to fly, and there may have been among them proposals to incorporate movable vertical rear vanes, but I consider mere suggestions as having no real place in the art.

Q162. In 1902, and before that time, you knew that others had proposed to steer a heavier-than-air flying machine by a vertical rear rudder which was

to be moved by the operator from side to side, did 331
you not?

A. Without referring to the literature on the subject which we had read at that time, I would not like to attempt to make a definite answer to this question, as it involves a matter of what we knew many years ago, and it is difficult to remember the date at which we first heard of such suggestion.

Q163. Please give your best recollection and answer the previous question?

A. I have no definite recollection at this moment.

Q164. You know now that others, previous to
1902, had proposed to steer a heavier-than-air flying 332
machine by a vertical rear rudder which was to be moved by the operator from side to side, do you not?

A. This is not a subject of which I have made a particular examination, and I would prefer to leave such questions to those who are more competent than I to answer this question, of the thousands of proposals of various kinds which have been made, it is not easy offhand to remember distinctly just what particular features are embodied in the various proposed machines. An examination of such suggestions should precede any definite answer. I do
not, at this moment, have a definite recollection as 333
regards any particular proposed machines.

Q165. I do not ask you to recollect all the details of different proposals, but only ask you to answer the question as put. Please read over Q164 and answer "yes" or "no" if you can.

A. As I have already stated, it would be necessary for me to examine such proposals in order to make a definite statement. I have not claimed to have expert knowledge on this point.

Q166. In answer to Qs. 138 and 139 you volunteered statements in regard to your vertical rear

334 surface which could be moved while in flight, and you stated that in your opinion it was "for the first time in the history of the world." Do you want to now go on record as stating that you cannot give any better answer to Q164 than you have done?

A. My answers to Qs. 138 and 139 had reference to the functional employment of such surfaces in free flight. On this subject I have given some attention, as I am familiar with the history of attempts to practice this art with real machines in actual flight so far as they have been performed in public, or in machines publicly described. I have not given special consideration to mere speculations
335 on the point covered in Q164, and I think I cannot give a more definite answer to it than I have already done.

Adjourned at 4.45 to to-morrow, Sept. 15, at 10.45, same place.

New York, N. Y., Sept. 15, 1911,
10:45 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

336 Q167. I am not yet satisfied that you have given the most sincere answer to Q164 that you can give. You say that you are "familiar with the history of attempts to practice this art with real machines in actual flights so far as they have been performed in public, or in machines publicly described." Is it not a fact that you are now aware that others than yourself and your brother had, previous to 1902, proposed to steer a heavier-than-air flying machine by means of a vertical rear rudder which was to be moved by the operator from side to side in so steering the machine?

A. I am sorry that you question the sincerity of my answer. I cannot agree with you. Regarding

the matter which you have quoted, I will say that 337
it is a general understanding of people familiar with the history of this art, that no real flying machines or flying machine art existed prior to the invention described in the patent in suit. There had been some experimental attempts to fly with actual machines. It is this class of machines that I referred to in the matter you have quoted. The last part of your question seems to imply that a vertical rear surface which might be moved by the operator from side to side, would constitute a steering mechanism similar to that of ships. I am quite certain that no one prior to us had proposed to use a movable
vertical surface with the knowledge that it would 338
function as a ship's rudder, or with the knowledge that it possessed the functions set forth in the patent in suit. And ignoring the question of whether a movable vertical rear surface would or would not steer a heavier-than-air flying machine, I do not now definitely recall any particular proposed machine containing a vertical rear vane movable from side to side by the operator. This is a matter regarding which I do not now have a definite recollection.

Q168. You, in your last answer, limit yourself to "with the *knowledge* that it *would* function as
a ship's rudder" (italics mine). I do not ask you 339
as to what your opinion is as to other persons' knowledge as distinguished from the proposals nor at present of what the results might or might not be. Nor do I ask you to describe any particular machine in detail.

Please read over Q167 again and answer it without any limitations other than expressed therein, and without any reservations.

A. If you will read the last two sentences of my answer to Q167, you will see that it covers the ground very completely, without remembering at

340 least one proposed machine I certainly cannot make any other answer.

Q169. I am asking merely as to your knowledge at the present time. It seems to me that you can answer the question embodied in Q167 "yes" or "no." Please do so.

A. My answer to Q67 contains the word "now." I do not propose to answer a definite "yes" or a definite "no" to a question on which I have no definite knowledge at this time.

Q170. Now Mr. Wright, is it not a fact that you are now aware that others than yourself and your brother had, previous to 1902, in publications which
341 you have read, proposed to steer a heavier-than-air flying machine to the right and left by means of a vertical rear surface movable by the operator like the rudder of a ship is moved?

A. Neither my brother nor myself, so far as I now recall, have proposed to steer or have steered a heavier-than-air flying machine in the manner that a ship's rudder steers a ship, whether any proposal such as you have mentioned is or is not contained in publications prior to 1902 is a matter on which, as I have already said, I have no definite recollection.

Q171. Then so far as your recollection goes at
342 the present time, your answer to Q167 is substantially "no?"

A. My answer is substantially that I do not know.

Q172. Then you desire to go on record now as stating here that you do not know that previous to 1902 in publications which you have read any one had proposed to steer a heavier-than-air flying machine to the right and left by means of a vertical rear surface movable by the operator like the rudder of a ship is moved? Is that correct?

By Mr. Toulmin: As the Court will have 343 noticed, the matter inquired about in the several preceding questions, is of no consequence, since no such matter is involved in the patent in suit, nor, as this record shows, in defendants' machines. Objection is made therefore to the whole subject as immaterial.

A. I do not desire to go on record as stating anything definitely on this particular point.

Q173. That is very evident, but I desire to get a definite statement from you. If you will not answer Q172 any further than you have just done, please say so.

A. As I have stated over and over again that I 344 do not possess the knowledge concerning this point necessary to justify a more definite answer, I do not see any possibility for meeting your desire.

Q174. What part of the matter inquired about in Q172 is there of which you do not possess the knowledge?

A. That previous to 1902 in publications which I have read, any one had proposed to steer a heavier-than-air flying machine to the right and left by means of a vertical rear surface movable by the operator like the rudder of a ship is moved?

Q175. And would your answer be that you have 345 no knowledge in regard to the matter, if the words "in publications which you have read" were omitted from Q172?

A. My answer would be the same. I cannot remember any such person.

Q176. Do you mean that you cannot remember any such person's name, or that you do remember such a proposal but cannot recollect the name of the person who proposed it?

A. It is not a question of names, but of particular machines or particular propositions. I cannot

346 recall any machine and say that I remember that it did possess a vertical rear surface as described in Q172.

Q177. You have answered as to "particular machines." Now, please answer as to propositions, that is, the way Q172 is put?

A. The same is true as to particular propositions.

Q178. Now returning to your 1902 machine which had the movable vertical surface in the rear, after that machine had lost its equilibrium and was in a tilted state, that is, with one wing lower than the other, did the machine glide straight
347 ahead, or veer off before the time the wings were warped, and if so, which way did it veer?

A. In such case the machine began to veer or slide toward the low wing, before the wings were warped to bring up the low wing.

Q179. That is, if, for example, the machine were tilted so that the left wing were lower than the right wing, the machine would begin to veer off toward the left, and would also begin to slide off toward the left. Is that correct?

A. I used the words "veer" and "slide" as having the same meaning. If you make a distinction between them, please explain it.

348 Q180. I do make a distinction. Sliding refers to a sliding down of the machine laterally of itself. By "veer" I meant a turning of the machine out of its original direction. Please answer with those understandings.

A. If by "original direction" you mean the path of the machine through the air, I see no distinction between "veer" and "slide," but if you mean by "turning of the machine out of its original direction" a turning of the machine on a vertical axis so that the longitudinal axis is turned from its original direction, then I will say that my answer to Q178 is not an answer to this last definition of "veer." It has reference to deviation from the original direction of motion of the machine. If you wish I will answer Q178 with the understanding that you mean by "veer" a turning on a vertical axis of the machine. 349

Q181. Then the machine remained in a tilted position with its longitudinal axis continually parallel to what it was, until the wings were warped?

A. I made no such statement. Do you wish me to make answer as to what occurred with reference to the longitudinal axis of the machine?

Q182. Please do so. 350

A. As stated in my answer to Q178, the machine began to slide sidewise from the original path toward the side of the machine on which the wings were low. This sidewise motion was resisted at the rear of the machine as a result of the fact that this side motion exposed the vertical rear vane to the action of the relative wind, the vertical vane no longer moving in the path of its plane. As the result of this resistance, the machine began to turn on a vertical axis so as to face more and more toward the side on which the wings were low. In my answer I have assumed that the wings have not been warped. 351

Adjourned for recess at 1 P. M. to 2:30 P. M.

Resumed at 2.40 P. M.

Q183. You have used the word "vane" in your answer. Did your answer refer to the 1902 machine which had the fixed vanes, or the one which had the vertical rudder which was movable?

A. I had in mind the one which was movable, but I assume that it has remained unmoved from its normal position.

Q184. Did not the machine turn off somewhat

352 toward the left, or tend to do so, beyond the effect caused by the sliding which you have mentioned?

A. I do not remember having specially noticed anything beyond this.

Q185. What curve did the main supporting surfaces on this machine have in 1902? Please state what the shape was, where the deepest point of curvature was, and its depth.

A. The main supporting surfaces had the deepest curve toward the front of the machine, owing partly to the curvature of the ribs, and partly to the fact that the front cross spar was on the lower side of the ribs at the extreme front and helped
353 to make up the curvature. I think the depth of curvature at this time was about 1/25th of the fore-and-aft dimension.

Q186. Wasn't it deeper than that?

A. I think not at that time.

Q187. In estimating the depth of curvature, you took into account the entire curve including the amount caused by the front spar?

A. I did.

Q188. What was the curvature transversely of the machine, that is, from tip to tip?

A. My recollection on this point is not very distinct, but my impression is that it was two
354 inches.

Q189. This transverse curvature was downward toward the tip, was it not?

A. It was.

Q190. Did it have on it (I am now speaking of the same 1902 machine) a horizontal rudder in front which could be curved in each direction, as described in the patent in suit?

A. Yes.

Q191. And this machine, if I understand you correctly, had the wire or cable which turned the rear rudder, fastened to the wires or cables which warped the wings. Is that correct?

A. When we decided to make the vertical rear 355
vane movable on a vertical axis, the question arose as to whether this movement should be effected by a handle or other means not directly connected to those operating the wing tips, and after some study we concluded that for the time being it would be wise to connect the control of the movable vane with the controlling cables of the wing tips, in order to simplify the mental effort necessary for the direction of the various controls as much as possible, and the flights were actually made with this interconnection between the movable tips and the movable vertical vane, or rudder
as we sometimes called it. 356

By Mr. Newell: The portion of the answer preceding the words "and the flights" is objected to as volunteered.

Q192. How long after that did you actually put onto a full-sized man-carrying machine and try it, if at all, any construction by which the operator in flight could move the rear vertical rudder a greater amount than it was automatically moved by the warping of the wings?

A. As you question me on matters which I have not been requested to look up in my note book for
the purpose of refreshing my memory, I cannot 357
attempt to give an exact answer to your question, but my recollection is at present that it was late in the year 1904, probably in November.

Q193. Such a construction, by which this additional movement could be given to the vertical rudder, has been used on substantially all your machines since that time?

A. Your question seems to imply that an "additional movement" could be given to the vertical

358 rudder. What do you mean by "additional movement?"

Q194. I mean a turning beyond that given to the rudder after the tips had been warped.

A. Without meaning to imply whether the movement referred to was an increase or decrease as compared with that imparted by the interconnection between the wing tips and the rudder or vertical vane, and without reference to the time when such movement occurred I answer that a slightly different embodiment of the invention in which the relative movements of the wing tips and rear vertical surface could be varied
359 has been used on substantially all of our machines since that time.

Q195. Such construction as you have just mentioned, allows the operator to warp the wings and turn the rear rudder, and to give an additional turning to the rudder after he has warped the wing, does it not?

A. Your use of the word "additional" is somewhat ambiguous to me, but if you mean it merely in the sense of "another," I think it does permit it.

Q196. In your present machines the operator
360 can warp the wings and turn the rudder to counteract the swerving of the machine due to the difference in resistances on the two wings, and then turn the rudder further in the same direction without further warping the wings. That is correct, is it not?

A. The particular object of the invention is to control lateral equilibrium, but this is so inter-related with steering, that both could be attained in all the machines in which we have incorporated this invention. As to the mere matter of capability of movement, it is a fact that

the vertical surface at the rear, after or during 361
the combined movement of the wing tips and vertical rear surface, can be adjusted so as to increase or decrease the movement first referred to.

Q197. Consequently the rudder can be at all times adjusted by the operator to exactly counterbalance the difference of resistance on the warped wing tips?

A. I think it possesses that possibility.

Q198. Well, doesn't it, as a matter of fact?

A. Are you referring to the purpose of this special adjustment?

Q199. No, I am referring to the capability of 362
the construction for allowing that operation.

A. I have stated that it possesses that possibility.

Q200. In your 1902 machine in which the vertical rear rudder was connected up to the wing-warping cables, how much could the cradle be moved laterally from the center of the machine?

A. I do not remember.

Q201. About how much?

A. Possibly five or six inches.

Q202. And possibly more? 363

A. That is my present estimate, five or six inches.

Q203. The operator lay on his stomach, and when he wanted to restore equilibrium he moved his body up along the surface toward the high side of the machine, carrying the cradle with him, and this warped the wings and consequently caused the rudder to be turned toward the high side. Is this correct?

A. If the high side was already higher than desired, this would be the proper movement.

364 Q204. The weight of the operator's body, being shifted toward the elevated side, therefore aided in the restoration of equilibrium, did it not?

A. That is my opinion.

Q205. Did you find with that machine (and we are talking about the 1902 machine) that, when equilibrium was lost and regained, the machine always preserved its original course, or did it sometimes turn off from its original course?

A. Please explain what you mean by "turn off."

Q206. I mean deviate.

A. The tilted condition of the machine always
365 tended to cause a deviation of the course of
the machine from its original course, though the amount of deviation naturally depended on the amount of tilting and the time during which it lasted. The tendency to deviate naturally lasted both during the time the machine was tilting and during the time that it was coming back to the level, as the deviation due to tilting continues during all the time the machine is tilted from its proper position.

Q207. Then during the time that equilibrium
was being restored by the use of the wing
366 tips and rudder, the longitudinal axis of the ma-
chine did not always remain parallel to what it was or in the same line, but changed to a greater or less angle. Is that correct?

A. In my answer to Q206 I made no reference to deviation of the longitudinal axis of the machine from the parallel. Do you wish me to answer this question as referring to different conditions than those mentioned in Q205 and Q206?

Q208. I will reframe the question. When equilibrium was lost in that 1902 machine by

one wing rising higher than it should be, and 367
you were attempting to bring the machine to horizontal equilibrium by the use of the wing tips and rudder, did the longitudinal axis of the machine always remain parallel to itself, or in the same line, or did it sometimes move off to an angle to its former position?

A. In machines of this type the machine slides sidewise toward the too low wing so long as that wing remains too low. If, during this time, the vertical rear surface remains stationary in its original plane, the longitudinal axis of the machine as a result of pressures produced by this condition
tends to move off so as to form an angle to its 368
former position, but if the low wing is adjusted to an increased angle and the high wing is adjusted in the opposite direction, the increased resistance on the low wing would tend to accentuate the moving off to an angle referred to above. If the rear vertical surface is now moved toward the side of the machine having the smaller angle of incidence, as happens in the operation of Complainant's and Defendant's machines, the pressure on the side toward the low wing having a greater angle of incidence is relieved and pressure is brought to bear on the side toward the wing having
the lesser angle of incidence. Consequently the 369
two tendencies to turn on a vertical axis are neutralized and the machine tends to proceed approximately in the original direction, with the wings approximately level.

(Reference to Defendant's machine objected to as volunteered.)

By Mr. Toulmin: No, the reference to Defendant's machine is not volunteered, but illustrative of the fact.

Adjourned at 4.45 P. M. to to-morrow, Sept. 16th, at 10.30 A. M., same place.

370 New York, N. Y., Sept. 16, 1911.

Met pursuant to adjournment.

Present—Counsel as before.

Q209. I show you here a drawing which apparently shows a construction for warping the wings and turning the rudder on the Wright machine. Apparently when the lever A is moved forward or back, it causes the warping of the wings because it actuates the warping chains seen in Fig. 1 on the far side of the lever. The segment D seems to be rotatable on the transverse shaft
371 independently of the movement of this lever, and when this segment D is moved, it turns the rear rudder. The short lever B pivoted to the top of the lever A is connected to this segment D by the tube shown. Consequently, with the short lever B in the position shown by dotted lines, a movement of the lever A forward, for example, and without moving the lever B to the right or left, causes the wings to be warped and the rudder to be moved. Is this construction used on your machine? I mean the Complainant's machines.

By Mr. Toulmin: It is noted that Mr. A. F. Zahm, who is noticed as a witness for
372 Defendants, is in attendance here at this time in the room listening to the testimony of Mr. Wright. No objection is made to his presence, but the fact is merely noted upon the record.

Counsel for Defendants introduces the drawing referred to, and requests that it be marked as Defendants' Exhibit "Drawing Present Wright Warping Lever."

A. This drawing and your statement as embodied in this question so far as I now note, are correct.

Q210. And assuming that the lever A has been 373
moved forward (thus warping the wings and turning the rudder), the rudder may be further turned in the same direction by moving the lever B laterally on its pivot C. That is correct, is it not?

A. The rudder may be turned either further or less far in the same direction by moving the lever B.

Q211. In other words, moving the lever A forward or back warps the wings and turns the vertical rudder toward the wing having the lesser angle of incidence (assuming that the lever B is in dotted position), and then, by moving lever B laterally
on its pivot in one direction or the other, the rud- 374
der may be adjusted to a greater or less angle as desired by the operator?

A. If by "greater or less angle" you mean angle to its original position, and construe "then" as not specially defining the time, I think I can answer your question "yes."

Q212. I think we understand each other, but to make it clear, what I meant by "greater or less angle" was with relation to the angle to which it was moved by the mere movement of the lever A. With this explanation your answer is "yes," is it not?

A. As I understand your idea, I would say "yes." 375

Q213. The "elevator lever" shown in Fig. 3 is a lever, separate and independent of lever A, for operating the horizontal rudder, is it not?

A. It is.

Direct Examination Closed.

WILBUR WRIGHT.

By Mr. Toulmin: No cross examination is desired.

376 Adjourned at 11.15 A. M. to resume on Monday, Sept. 18th, at 10.30 A. M.

By Mr. Toulmin: It is not thought that these long adjournments, particularly the one just noted, is making the proper use of the time in view of the last order of the Court, nor does it seem fair to Complainant that Mr. Wright and his Counsel should be kept waiting in this manner. The object in noting this on the record is that the Court may see the situation should an application for more time be made by Defendants.

377 By Mr. Newell: I asked Counsel for Complainant yesterday if he would have any cross examination of Mr. Wright, and he said that he could not tell until I was through. I cannot put on another witness today, as I desired to put them on in the order in which I contemplated doing so, but expect to have the witness ready on Monday morning. Today is Saturday.

New York, N. Y., Sept. 19, 1911.
11:00 A. M.

378 Present—Counsel as before.

PAUL W. BECK, a witness introduced on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

By Mr. Toulmin: The witness now called is not named in the notice under which these depositions are being taken. But no objection is made to this; provided a similar privilege is accorded complainant when it comes to take its rebuttal, should occasion require, as the calling of a witness or

two who might be desired, in addition to 379
those named in the notice.

Counsel for defendants declines this offer, and hereby gives notice that, if Mr. Toulmin insists on making objection to the witness's testifying at this time, he will put on Captain Beck tomorrow morning at 10:30 A. M. at the same place, and this notice also includes Lieutenant Theodore G. Ellyson, of Annapolis, Md. Counsel only knew that Captain Beck was available late yesterday afternoon.

By Mr. Toulmin: As stated, I have no objection
to the immediate examination of 380
Captain Beck, as also of the other witness just named, provided, only, a similar privilege is to be accorded me in the taking of the rebuttal should I unexpectedly come across one or two witnesses not named in the notice, as counsel claims he has come across these witnesses. The responsibility for the delay to the adjournment until tomorrow rests with opposing counsel, as I am here and ready to go on under the fair conditions stated.

Counsel for defendants will accept the 381
proposition of Mr. Toulmin as to Captain Beck and Lieutenant Ellyson, as the "one or two witnesses" mentioned.

Adjourned to 10:30 A. M., Sept. 20th, at same place.

382 New York, N .Y., September 20, 1911.
10:30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

> Counsel for defendants states that the offer by him is withdrawn because counsel for complainant would not agree to his putting on Captain Beck yesterday. Lieutenant Ellyson is now put on because he is anxious to get away as soon as possible.

> 383 By Mr. Toulmin: The record does not show that I declined to go on with Captain Beck yesterday. I merely point back to what the record does show.

THEODORE G. ELLYSON, a witness introduced on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence, and occupation?

A. Theodore G. Ellyson; age 26; residence, Richmond, Virginia; occupation, naval officer.

384 Q2. You are a Lieutenant in the United States Navy?

A. Yes.

Q3. What duty are you now on, and what did your orders direct you to do, and when were those orders given you?

A. On December 23, 1910, I was ordered to report for instruction in practical aviation and for duty in connection with experimental aviation for the development of naval aviation. I reported to Glenn H. Curtiss at Los Angeles, California, on January the 2d, 1911, and have been with him since that date, carrying on experiments for the Navy Department. 385

Q4. Where was Mr. Curtiss' flying headquarters at that time?

A. At that time he was undecided as to whether his permanent headquarters would be Los Angeles, California, or San Diego, California, but on January the 17th, he formally opened his flying headquarters at North Island, San Diego, California.

Q5. If you saw or witnessed an experimental flight or flights there in March, 1911, please state about when that was if you recollect?

A. On or about March the 11th, Mr. Curtiss 386
made several experimental flights to demonstrate the use of the ailerons and of the rudder. The first of these flights were made by Mr. Curtiss alone. Later I made two flights as a passenger with him to observe the use of the rudder and the ailerons, and also observed two flights which he made with Captain Beck as a passenger.

Q6. Was this machine a biplane with a vertical rudder in the rear and with an aileron at each side of the machine pivoted to the rear posts, and with a horizontal rudder in front?

> By. Mr. Toulmin: Objection is made to 387
> the testimony given and about to be given concerning alleged tests, as the same appears to have been conducted *ex parte* and without the presence or knowledge of complainant. This objection is made once for all.

A. Yes.

Q7. The machine also had a shoulder control or frame hinged to the seat so that it could be moved laterally in either direction by the operator's shoulders, and the wires to the ailerons were attached to this shoulder frame so that neither ail-

388 eron could be moved without moving the shoulder frame.

A. Yes, if the shoulder frame was moved, the ailerons were moved in opposite direction and the ailerons could not be moved without moving the shoulder frame.

Q8. This machine had an engine on it and single propeller for driving it?

A. Yes.

Q9. Please describe what, if any, preparations were made for defining or guiding or indicating on the ground a path to be flown over?

A. The aviation field on North Island is mostly
389 covered with sagebrush or mesquite, and in order to obtain smooth ground for initial instruction in flying a stretch about fifty feet wide and a little over a mile long, had been cleared of all brush and grass and scraped. The flights were made over this course.

Q10. Was that path straight, or otherwise?

A. It was a straight path.

Q11. Please first describe the flights made by Mr. Curtiss alone and as to whether or not you observed him using the ailerons, and as to whether or not any spinning or swerving of the machine occurred due to the use of the ailerons?

390 A. I observed Mr. Curtiss make two flights over this straight course alone. The machine rocked from side to side as a result of the use of the ailerons, which could be seen, but did not go to one side or the other of the path or road above described. I observed these flights through field glasses and know that the ailerons were frequently used. On the first flight, that is when the machine was going away from me, I could detect no movement of the vertical rudder. On the second flight it was impossible to see the vertical rudder as the machine was coming towards me.

Q12. Please state what, if anything, Mr. Curtiss 391
asked you to watch out for?

A. Before the flights Mr. Curtiss stated that he would not use the rudder unless necessary to bring the machine back on the course. There was a slight side wind which he was afraid would drift him over the sagebrush, and he asked that we watch particularly to see that the ailerons were moved and to see what would be the effect on the machine, as he wished to prove to us that the use of ailerons did not tend to swerve the machine from one side or the other out of a straight course.

Q13. Was there any swerving of the machine
detectable at any time due to the use of the ail- 392
erons?

A. There was none.

Q14. You have said that Mr. Curtiss "wished to prove to us," etc. Please state who you mean by "us."

A. I don't remember all who were there at the time, but I was referring to Captain Beck, Lieutenant Walker, and Lieutenant Kelly of the United States Army, and myself.

Q15. Captain Beck is Captain Paul W. Beck?

A. Yes, and was at that time under instruction
at the Curtiss School on North Island, and since
then has been in charge of a Curtiss machine be- 393
longing to the Army.

Q16. If you made any flight or flights thereafter with that machine over that course as a passenger with Mr. Curtiss, please describe them.

A. I made two flights as a passenger with Mr. Curtiss, each flight being a little over a mile. The course runs almost due North and South, and at the time the flights were made there was a wind from the Northwest. On the trip going North the rudder was not used at all. The ailerons were used, and the machine was rocked both to the right

394 and to the left, but did not swerve from the straight path. On the trip South the ailerons were again used and the rudder was used once, as the wind had drifted the machine from the path. The use of the rudder was not caused by any movement of the ailerons. My seat in the machine was immediately in the rear of Mr. Curtiss and I was in such position that I observed every movement of both the ailerons and the vertical rudder.

Q17. If Captain Beck made any flights as a passenger with Mr. Curtiss and which you observed, please state what they were and whether or not you detected any swerving of the machine
395 when the ailerons were used?

A. Captain Beck made two flights as a passenger with Mr. Curtiss just after and under similar conditions to those made by myself. I stood at the end of the course and observed that the ailerons were freely used, and the machine did not swerve from the course.

Q18. Was any change made in the ailerons or the wires which operated them, between the time when Mr. Curtiss made the flights (which you have mentioned as made by him alone without a passenger) and the time when the flights were made in which you were carried as a passenger
396 and afterwards Captain Beck carried as a passenger?

A. No; no changes were made in the machine or in the wiring. That is, all flights were made under exactly similar conditions with the machine.

Q19. Is Lieutenant Kelly, whom you have mentioned, now alive?

A. No.

Cross examination by Mr. Toulmin:

XQ20. Did Mr. Curtiss in the first flight with you as a passenger steer the machine along the fifty-foot path by the ailerons alone, without any use of the vertical rudder? 397

A. The ailerons had no steering tendency. When they were used, the machine rocked from side to side, but did not swerve. He simply started in a straight line and kept flying along that line, without the use, or with a very slight use, of the vertical rudder, the vertical rudder being used only when starting from the ground, not after once getting on the course.

XQ21. In your experience in flying this Curtiss machine, have you found that the machine would fly as much as a mile, in a straight line, without 398
controlling its direction in any way yourself?

A. I have never flown the machine over a marked course to determine how far it would go, without use of the control, but in flying over Lake Keuka at Hammondsport, New York, I have flown as far as four miles without appreciable use of the ailerons or rudder.

XQ22. What do you mean by "appreciable use?"

A. I mean that to the best of my knowledge I did not use them at all.

XQ23. By "to the best of your knowledge" do 399
you mean that you may have used those devices in a sort of unconscious manner, just as a man balances himself in walking without being conscious of an effort to balance?

A. I do not think so, because even a slightest movement of the rudder would cause the machine to deviate, and a slightest movement of the ailerons would distrub the lateral balance of the machine.

XQ24. How large a movement of the rudder would cause such deviation?

A. Any movement of a vertical rudder, no mat-

400 ter how slight, would cause the machine to deviate from a straight course.

XQ25. In this flight of four miles you referred to, did the machine land in exactly the same course or position as when it left the ground, that is, was its longitudinal axis in the same direction when it landed as when it rose?

A. In the instance quoted, no landing was made. I was simply flying for practice over the lake, and remember this instance when you asked me a question about my experience in flying a Curtiss machine and whether or not it could be flown for as much as a mile without movement
401 of the vertical rudder or ailerons. On this flight I was in the air approximately thirty minutes, and this straight-away flight occurred during that time. I remembered it from the fact that it was the smoothest flying I had ever experienced.

XQ26. But would you say that you are sure that the machine did not deviate, say as much as fifty feet, from a straight line during this four-mile flight, or any one mile of it?

A. When I started down the lake on this flight I was headed for what is known as Urbana Point, or rather a dock on that point. When I reached
402 Urbana I was over this dock and, as stated, did not use rudder or ailerons, to the best of my knowledge. For this reason I am sure the machine did not deviate from a straight course, as had it done so it would have required a movement of the rudder to bring it back to that course.

XQ27. Do you really mean that during that particular flight when you seemed to have an unusual experience, that the machine did not at some time along the course deviate off as much, say, as fifty feet, although it may have finally come to the points you have made?

A. You asked for information concerning my experience in flying. It has always been my experience that the machine will not deviate from a straight course, unless the rudder is used, or unless the machine is drifted as a whole by the wind, and on this experience I base the above answer, that it did not deviate fifty feet from one side or the other out of its course. 403

XQ28. Do you state as a positive fact and without qualification, that during that particular flight of four miles the machine actually did not deviate from a straight course as much as fifty feet?

A. Yes.

XQ29. Was this particular experience you have related an unusual or common one? 404

A. It is unusual in that it was the first time I remembered having flown for such a long time without use of either the ailerons or the rudder, and that is what impressed the experience on me so forcibly.

XQ30. You will please state what you mean by the term "swerving" as you have used it?

A. I mean in a change of direction of flight, that is, a deviation to one side or the other of the line in which the machine is flying.

XQ31. When you were flying as a passenger with Mr. Curtiss and the rear vertical rudder was 405
behind you, did you turn around and watch the rudder during the flight?

A. I did not. This rudder could not have moved without turning the wheel on the vertical control post which was immediately in front of me.

XQ32. Then as you could see the wheel, please state whether during that flight it was moved bodily in a fore-and-aft direction as in operating the horizontal rudder?

A. It was moved both forward and aft.

XQ33. Then could not a slight rotary movement

406 of the wheel have taken place without your being able to accurately observe the extent of the rotary movement?

A. No, I think not, as there was a mark on the wheel which was in line with the push rod to front control and I could have noticed the slightest movement by a line on these two.

XQ34. As Mr. Curtiss was between you and the wheel and the push rod, as you said you were sitting behind him, did you have to look from one side to the other of his head or shoulders so as to see this wheel and mark on the push rod?

A. I did not, as my seat was at an elevation of
407 approximately five inches above his, being placed further up the diagonal.

XQ35. Will you testify that during the whole of that flight you kept your head still and your eye directly on the wheel and the mark on the push rod, all the time?

A. Yes, as the sole purpose of the flight was to determine whether the rudder was moved in even the slightest degree, and whether or not the machine deviated from a straight path, which could easily be seen by observation in this manner.

XQ36. And you achieved that feat of so constantly keeping your eye on the wheel and the
408 mark during the whole time of the flight with the aeroplane rocking from side to side and Mr. Curtiss manipulating the ailerons, did you?

A. Yes.

XQ37. How many times before that had you ridden on an aeroplane in flight?

A. Between sixty and seventy times.

XQ38. Well, what I mean is all told, how many minutes had you spent on an aeroplane in flight before the particular flight in question?

A. As nearly as I can determine, approximately three hours.

XQ39. And at the end of this flight when you

were riding with Mr. Curtiss, did the machine 409
descend to the ground without turning back to its course?

A. Yes, the flight was a straight-away.

XQ40. Then as the purpose was to show you that the rear vertical rudder would not be needed at all when the ailerons were operated, why was not the rear vertical rudder taken off the machine altogether and the test made in that way?

By Mr. Newell: Objected to as immaterial.

A. The purpose was to show that the ailerons
did not cause the machine to deviate from a straight 410
course. As there was a wind blowing with approximately a force of 15 miles an hour which might have drifted us over bad ground, it would have been extremely foolish going into the air without some means of returning to a safe landing. The wind was approximately Northwest, between Northwest and North.

XQ41. Please state specifically whether this wind was blowing diagonally or across the course?

A. The course was North and South, and the wind between Northwest and North.

XQ42. Then as these conditions obtained or ex-
isted and as the rear vertical rudder was on the 411
machine and Mr. Curtiss kept his hands on the wheel which controlled that rudder, is it not true that he utilized the rudder to keep the machine from departing from the fifty foot course?

A. It is not, unless at the start the vertical rudder was slightly to one side to counteract the drift of the wind. It was not used after once getting away from the ground.

XQ43. You mean that the rear vertical rudder was adjusted and held by Mr. Curtiss somewhat to one side during the act of running over the

412 ground to the rising point and then continued in such position through a portion of the flight, or through all of the flight?

A. In running over the ground it was necessary to use the rudder. After once getting in the air and at the flying level approximately twenty feet, the rudder was not used from then until the end of the flight.

XQ44. And by "not used" you mean not manipulated or turned, but merely kept in this one side position during the remainder of the flight, so as to counteract the side drifting effect of the wind?

413 A. I do not know that it was to one side or the other, but I do know that it was not moved.

Redirect examination by Mr. Newell:

RDQ45. Was or was not the steering wheel in plain sight of you at all times during the flight?

A. It was.

RDQ46. During the flight did the aeroplane rock both ways, that is, with one end depressed at one time and the other at another time, and if so did it do this more than once?

A. Yes, it rocked to both the right and the left several times.

414 RDQ47. Please state whether or not you would have been able to see any movement given to the wheel, if there had been any?

A. Yes, I saw all movements of the wheel and observed movements in the fore-and-aft direction, but no rotary movement of the wheel.

RDQ48. You went up for this special purpose, that is, to determine this fact?

A. Yes, and that is why I devoted all my attention to watching the wheel.

T. G. ELLYSON,
Lieutenant,
U. S. Navy.

Adjourned for recess at 1 P. M. 415

Resumed at 2 P. M.

PAUL W. BECK, having been heretofore introduced and sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence and occupation?

A. Paul W. Beck; age 34; residence, Washington, D. C.; occupation, officer of the Army.

Q2. You are a Captain in the United States Army?

A. Yes. 416

Q3. If you were in San Diego, California, in March, 1911, please state how you happened to be there and what duty you were on?

A. I was in San Diego, California, during the month mentioned, having been detailed by the Commanding General Department of California, to learn the construction and operation of the Curtiss type aeroplane.

Q4. Do you know Lieutenant Theodore G. Ellyson, of the Navy, and, if so, please state how long you have known him and whether he was in San Diego at that time at the Curtiss camp?

A. Yes; I do know Lieutenant Ellyson, and 417 have known him since the first part of January, 1911. He was at the Curtiss camp at San Diego, Cal., during the entire time that I was there.

Q5. If you witnessed or took part in any flights at North Island at San Diego in March, 1911, when Lieutenant Ellyson and Mr. Curtiss were present, and which were made for the purpose of determining whether the use of the ailerons caused any spinning or swerving of the machine, please describe what preparations were

418 made, or had been made, for indicating on the ground the course to be followed?

> By Mr. Toulmin: This and any further testimony as to *ex parte* tests is objected to as incompetent. Such objection is made once for all.

A. I was present at North Island where the flying grounds of San Diego are located, during a series of tests for the purpose mentioned in the question. There was no special preparation of the field for these tests. North Island is covered by sagebrush and low brushwood of various
419 kinds and there are a number of large tree stumps on it. Through these obstructions a course fifty feet wide and approximately one mile and a quarter long had been cleared as a runway for use in the school of instruction in aviation. This was the course used in conducting the tests of which you ask.

Q6. Was this course straight or curved?

A. It was straight; lying in a north and south direction.

Q7. Lieutenant Ellyson has testified in substance that in March, 1911, you were present when Mr. Curtiss made flights over this course
420 and afterwards carried him as a passenger, and also made other flights in which you were carried as a passenger. If you were present and witnessed those flights, please state what, if anything, you were told to observe?

A. I was present during such flights both when Lieutenant Ellyson was a passenger with Mr. Curtiss, and naturally when I myself was a passenger. I also am aware that Mr. Curtiss made several flights alone during these tests. I am not positive that I personally witnessed these

flights of Mr. Curtiss when he flew alone. When 421
I flew with Mr. Curtiss, he requested me to observe particularly whether or not he used his vertical rudder at any time during the flight. Also to note whether or not he moved his ailerons either to disturb his lateral balance or to restore said balance, and particularly to observe whether or not he used his vertical rudder at the same time, that is to say in unison with the ailerons.

Q8. You were present part of the time this morning when Lieutenant Ellyson was testifying as to flights made by him as a passenger with Mr.
Curtiss, and by you as a passenger with Mr.
Curtiss over this course. Are these the same 422
flights that you have just mentioned?

A. They are.

Q9. Mr. Ellyson flew as a passenger with Mr. Curtiss before you were carried as a passenger?

A. He did.

Q10. First in regard to those flights with Lieutenant Ellyson. Did or did not the machine follow the course, and was there or was there not any spinning or swerving of the machine due to the use of the ailerons?

A. So far as I could observe from my position
on the ground, immediately in prolongation of this 423
course there was no spinning or deviation of the machine from the straight air-line course immediately above the ground course.

Q11. Please state just what you mean by "the ground course."

A. I refer to this fifty foot wide course, mentioned above.

Q12. In those flights with Lieut. Ellyson, did the machine rock from side to side (as in losing and regaining equilibrium), and if so, roughly about how many times?

A. The machine did rock from side to side during

424 the flights when Lieut. Ellyson was a passenger with Mr. Curtiss. I should say, roughly, at least five or six times to my observations.

Q13. After having gotten the machine following the course in flight, how long was the free flight to the landing point, I mean roughly?

A. It was approximately one mile in the clear from the point of rising to the point where we usually descended. On the occasion of the flights in question, in my opinion they were approximately of one mile length.

Q14. Did you follow the flights through field glasses?

425 A. I did not follow Lieut. Ellyson's flights with field glasses.

Q15. In the flights which you made as a passenger with Mr. Curtiss in that same machine following Lieut. Ellyson's flight, where did you sit in the machine?

A. I sat between the diagonal braces immediately in rear of, and slightly above, Mr. Curtiss.

Q16. From your position could you, or could you not, plainly see the steering wheel?

A. I could.

Q17. Could you also observe whether the shoulder frame for operating the ailerons was
426 moved by him?

A. I could, and did see it so moved.

Q18. In that flight which you made was balance lost and regained in each direction, and, if so, roughly about how many times?

A. Yes, balance was lost and regained a number of times. I should say roughly, at least twelve times on each flight.

Q19. How many flights did you make as a passenger with Mr. Curtiss on this occasion?

A. On this occasion I made two flights, both straight-away, and each of approximately one mile in length, one to the North, the other to the South. 427

Q20. Did the machine follow the course, that is, the straight path which you have mentioned?

A. It did on both flights.

Q21. Please state whether or not you could detect any spinning or swerving of the machine due to the use of the ailerons, either when they were used or thereafter?

A. I did not detect any tendency of the machine to spin or swerve at any time during either flight.

Q22. Were you or were you not watching this question while those flights were being made?

A. I was watching this particular question, as
I considered it the most important point in the 428
experiment.

Q23. Did or did not Mr. Curtiss rotate the steering wheel, or in any way cause the vertical rudder to be moved during the time or after the balancing was accomplished by the use of the ailerons?

A. He did not.

Q24. Did you watch particularly to see whether he did or not?

A. I did.

Q25. Was there any breeze at the time you made your flights, and, if so, please state its direction and about what its force was?

A. There was a light breeze from the North 429
Northwest which fluctuated, during the time of
these experiments, from about fifteen miles an
hour at the time of Lieut. Ellyson's flights, to about
five miles an hour at the time of my second flight.
At the time of my first flight it was blowing approximately at the rate of ten miles an hour.

Q26. That is what would be considered a very gentle breeze, isn't it?

A. Under the circumstances, it being steady, it was.

Q27. As this gentle breeze was somewhat across the course, did or did not the machine remain

430 with its central longitudinal axis always directed along the center of the course, or was the machine straightened out after leaving the ground so that the central longitudinal axis was at a slight angle to the course?

A. As nearly as I can remember, on the first flight there was a slight angle between the central longitudinal axis and the ground course. On the second flight there was no angle.

Q28. Was your first flight up the course toward the north?

A. It was.

Q29. And your second flight was toward the
431 south?

A. It was.

Q30. Did the machine, in that first flight toward the north (with you as a passenger) remain during the flight with its axis slightly at an angle to the course, or did it not?

A. To the best of my recollection, it remained at a slight angle during the entire flight.

Q31. Have you ever flown a Wright aeroplane?

A. I have flown in a Wright aeroplane as a passenger on a number of occasions, and have actually flown the machine assisted by a compe-
432 tent aviator on one occasion.

Q32. When was this that you flew the Wright machine?

A. Last week at College Park, Maryland.

Q33. Who was the aviator with you at the time?

A. Second Lieutenant T. DeW. Milling, 15th U. S. Cavalry.

Q34. In that Wright machine, what happens when the machine is tilted, say with the right side down, if the wings are warped so that the right wing is warped downward and the left wing

upward, and the rear rudder not moved toward 433
the left wing? I mean if at the time you are sailing straight-away.

A. If the wings are warped as described in the question, and the vertical rudder is left at the neutral position, there is a tendency to turn or swerve toward the low side.

Q35. If the rudder is not turned but left in its central position, would both wings move straight ahead, or will one wing be checked and sink, or fail to rise? I mean, of course, assuming that the wings are warped.

A. In the case you mention, there would be a 434
tendency for the low wing to drop still lower.

Q36. Is this so in the Curtiss machine?

A. Under the analogous condition, that is to say, when the ailerons are operative so as to produce a lack of lateral equlibrium, so long as the angle at which the ailerons are set is not changed, there is no tendency to further increase the amount of divergence from the normal. By "normal" in this particular case I mean the angle at which the machine is flying when the ailerons produce this first deviation from the horizontal. When a tip is produced laterally by the operation of the ailerons the angle of such tip will not be in- 435
creased so long as the ailerons remain at that same angle with respect to the main planes.

Q37. In the Curtiss machine, is there any divergence of the machine from its course due to the use of the ailerons, so far as your experience and operation of it enables you to judge?

A. None whatever.

Q38. Then in the Curtiss machine is, or is not, the vertical rudder moved to check or counteract any spinning or swerving of the machine due to the use of the ailerons?

436 A. In my own experience with the Curtiss machine, as a pilot, I have never had to use the vertical rudder for such a purpose. In my experience in the Curtiss machine as a passenger, I have never noted it so used.

Cross examination by Mr. Toulmin:

> By Mr. Toulmin: Without waiving the objection to the incompetency of the evidence concerning the *ex parte* tests, the cross examination is proceeded with.

XQ39. In speaking of the flight of Lieut. Ellyson with Mr. Curtiss, you said that so far as you could
437 observe there was no spinning or deviation of the machine from a straight air-line. As the machine was rapidly receding from you, you could only observe it for a few seconds, could you not?

A. I could observe any spinning or swerving from where I stood for a distance of about one-half mile down the course.

XQ40. You mean of course that your view became dimmer as the machine receded in its rapid flight from you?

A. Yes, and I noted at the time that beyond one-half mile I could not distinguish with sufficient clearness to testify.

438 XQ41. And again, during the time that you could observe, as you have stated, the longitudinal axis of the machine was at an angle to the course and to your line of vision, was it not?

A. That I am not certain. I aligned the center of the machine on the end of the course and a prominent land-mark across the bay on the hillside. I do not think that even at the start, certainly not after the machine had gone an eighth of a mile, I could have observed so slight an angle as must have existed—if any, between the longitudinal axis and the course.

XQ42. Then if you could not have discerned the 439
angularity of the longitudinal axis of the machine compared with the line of course, as stated in your last answer, you could not also detect with certainty any turning of the machine on a vertical axis due to the manipulation of the ailerons, you being on the ground and the machine rapidly receding from you. Is not this correct?

A. The conclusions would not necessarily follow as drawn in your question, for the reason that I was particularly observing the lateral swaying of the machine and the direction of the machine to a definite point. It is possible that had the
object of these experiments been to determine 440
whether or not there was any divergence between the longitudinal axis of the machine and the course, I would now be in a position to give definite testimony on that point. In other words, I paid no attention to this divergence.

XQ43. And would you say that your last answer is true as to all of the experiments made that day?

A. It is true in so far as it relates to flights made in my presence by persons other than myself.

XQ44. Well, was it not also true in the case of experiments where you rode as a passenger?

A. Yes, it is true in so far as the statement of 441
the main object of the experiment. The physical realization that the longitudinal axis of the machine was not parallel to ground course in my first flight, was more or less subconscious.

XQ45. And during the flight when you stood on the ground and the machine proceeded away with its longitudinal axis at some angle to the line of the course, what do you say was the position of the rear vertical rudder?

A. I am not aware that I have ever stated that the machine ever left the ground during these ex-

442 periments, with its longitudinal axis at an angle. I do not know whether it ever did or not.

XQ46. But my last question does not say that the machine was yet on the ground while the longitudinal axis was at an angle. If you will read the question you will see that it speaks of the angular position while the machine was flying away from you. As so explained, please answer.

A. I understood the question as it is now put, and answered it in that sense.

XQ47. You have stated that the machine went along the course with its longitudinal axis as some angle to the course. What I want to know
443 is, what was the position of the rear vertical rudder while the machine was in flight in such angular position? I refer you to your answer to direct question 27 which refers to a flight when you were a passenger. But as I understood from your testimony, the wind was blowing from the same direction and fluctuated from fifteen to five miles an hour while Lieut. Ellyson was a passenger, I have assumed that the same angulartiy of the axis of the machine would have been manifest while he was flying as when you were a passenger. I therefore would now ask whether you did observe the angularity of the longitudinal axis of the ma-
444 chine, to the course, while the Lieutenant was a passenger, as well as while you were a passenger.

By Mr. Newell: Counsel for defendants objects to the question, or rather to the statement preceding the question, as not stating what the witness testified. I refer particularly to Q27 and the answer and to the answer to Q25, showing that the witness did not state what counsel has put down in his above question.

Possibly the question is not clear, and I would ask counsel whether he means by

"angularity of the longitudinal axis of the 445
machine to the course," a divergence of the axis when the ailerons were moved, or whether he means such constant angle to the course as the machine retained during the flight. This should be explained in order that there may be no ambiguity as to what the question means.

By Mr. Toulmin: I mean what is embraced in question and answer 27 as to the position of the machine and the time of such position.

By Mr. Newell: The witness is instructed
that in giving his answer he may explain 446
exactly what he means and what he did mean in answering the above questions, so that there may be no ambiguity.

A. I did not observe any angularity of the longitudinal axis of the machine during any flight upon the day in question, save the one flight in which I was a passenger and which is referred to in question and answer 27.

XQ48. Do you deny that the machine during the flights when Lieutenant Ellyson was a passenger had the same, or substantially the same,
to use your words in answer to Q27, "slight angle 447
between the central longitudinal axis and the ground course," seeing that the wind was blowing harder during those flights than during your own trips?

A. I do not deny it. I simply state that I did not observe it.

XQ49. The conditions which would have necessitated such angle between the central longitudinal axis and the ground course were present during the flights when the Lieutenant was a passenger, were they not?

448 A. Presumably they were.

XQ50. In looking to your answer to direct question 25, would you say that such conditions were present?

A. As an expression of opinion merely, I would.

XQ51. Were not the conditions which would have necessitated such line of position of the machine equally present during the Lieutenant's flights as during your own flight alluded to in your answer to direct question 27.

A. They were, assuming that the wind was the only factor.

XQ52. Under the conditions stated in your an-
449 swer to direct question 27, what was the position of the rear vertical rudder with respect to the longitudinal axis of the machine?

A. It was in prolongation of the longitudinal axis, that is to say, there was no lateral divergence between the vertical rudder and this axis.

XQ53. Is it your understanding that the one point you were to specially observe in the experiments of that day was that the center of the machine followed approximately the center of the line of the clear path, regardless of the movements of the ailerons? By "the center of the machine"
450 I mean the point half-way between the wing tips.

A. I think I have so stated in my direct testimony, but to make the point clear I wish to now state that if it were found that the machine did follow this straight line in spite of the fact that the ailerons were more or less constantly worked so as to alternately raise and lower the wings while the vertical rudder was not brought into use, the separateness of the ailerons from the rudder would be proven. It was perfectly practicable to feel the lateral deviation, to see the operation of the wheel controlling the vertical

rudder, and keep my eye on the course simul- 451
taneously.

Adjourned at 4.45 P. M. to to-morrow, Sept. 21, at 10:30 A. M., same place.

New York, N. Y., Sept. 21, 1911,
10.30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

XQ54. Referring to the condition of the defend-
ants' machine as described in your answer to di- 425
rect question 36, please state how long that condi-
tion could continue?

A. Theoretically it could not continue at all. Practically I have had it continue to exist for a distance of a half mile when the ailerons were turned to produce a slight angle to the main planes. This on a straight course.

XQ55. And what then happened to the machine at the end of this half mile stretch?

A. I used the ailerons so as to restore lateral
equilibrium. This was with an accidental test
which occurred at College Park, Md. about two
weeks ago. 453

XQ56. And what was about to happen with the machine that caused you to then operate the ailerons to restore lateral equilibrium?

A. I was simply flying for amusement and experience and leveled the machine to continue my flight, having satisfied myself that the machine could be flown with one wing at a constant lower level than the other.

XQ57. But I do not think you have really answered the question. I wish to know what would have happened to the machine if you had not brought it back to the level?

454 A. Had the conditions remained the same, nothing would have happened until it might have become necessary to make a turn or a landing.

XQ58. You say "if the conditions remained the same." What conditions do you refer to?

A. I refer to the atmospheric conditions.

XQ59. Then if the machine had been subject to atmospheric disturbances during this little half mile flight, you would have had to bring the machine to a level, to save it from a fall, or a tendency to fall, would you not?

By Mr. Newell: The question is objected to as indefinite as to what is meant by "at-
455 mospheric disturbances." These may be of different kinds.

A. That does not necessarily follow. However, the function of these ailerons is to restore equilibrium and not to disturb it. The experiments I performed was abnormal and of no particular use, except to give me more confidence in my machine. Had there been any sudden change in the atmospheric conditions, I most certainly would have righted the machine the instant I discovered such disturbance. This without regard to the question of falling, or a tendency to fall.

456 XQ60. Then this brings it back to your answer to XQ54, in which you say that theoretically the condition of defendants' machine as described in your answer to direct question 36 could not continue at all. Please state why it could not?

A. Theoretically a rotation in a vertical plane at right angles to the longitudinal axis of the machine will continue if once started by the use of these ailerons, for the reason that the forward pressure from the propeller is constant and the center of weight lies in the longitudinal axis.

XQ61. Then if this rotation in a vertical plane

at right angles to the longitudinal axis of the ma- 457
chine will continue if once started by the use of these ailerons, the machine would become tilted laterally to such a position as to fall unless this rotation you speak of were corrected or counteracted, would it not?

A. Theoretically if this rotation were once started, it would be necessary to use the ailerons in the opposite direction in order to overcome the tip. Otherwise the machine would undoubtedly turn over.

XQ62. And that accords with practice, does it not?

A. Not in the case which I cited above. I have 458
stated that my practical experiments with the Curtiss machine have not borne out this theory.

XQ63. But you said the one instance you gave was abnormal as distinguished from usual. So I again ask you if this theory of operation which you have stated accords also with what generally takes place in practice?

A. We are, I think, talking at cross purposes. The abnormality to which I allude is my flying with the machine out of balance. Normally we bend every effort to keep our machine in balance when in flight. I do not know whether or not all Curtiss type aeroplanes will fly as I have said 459
this particular machine flew. As a matter of fact I have never tried it on any other machine.

XQ64. You still have not given a direct answer to the question. But I will again ask you, as a matter of practice, how long the condition stated in your answer to Q36 could continue, if you feel that you are informed upon the matter and can exactly answer the question?

By Mr. Newell: In order that there may be no doubt about what the witness means, 460 I suggest that the witness first explain what the conditions are to which he is referring, not by reference to any particular answer, but by complete statement, in order that the Court may know just what is meant.

By Mr. Toulmin: The above statement is an improper one to make and an interference to the right of cross examination. The witness himself stated a condition or position of the machine and we have the right to ask him anything concerning such condition or position.

A. I have already twice answered this same
461 question, to the best of my knowledge and belief. If the attorney will kindly explain to me what hidden point he is trying to bring out, I will be more than happy to answer it.

XQ65. There is no hidden point that I know of. The question is a very simple one. You stated a certain condition or position of defendants' machine in your answer to direct question 36. All I am asking you is to state how long the machine could remain in such position or condition, aside from the abnormal instance you have cited?

By Mr. Newell: As counsel for com-
462 plainant does not see fit to explain the assumed condition of the machine, he instructs the witness that he is at liberty to first explain what he, the witness, understands it to be, before answering the question.

By Mr. Toulmin: The pretense that any explanation is needed by counsel for complainant is objected to as merely means of diverting or interfering with the cross examination.

A. It is still my opinion that I answered this in XQ56.

XQ66. But your answer to XQ56 is confined to 463
your abnormal amusement flight. My last question eliminates that. With this explanation, kindly answer the question.

A. In the light of this explanation, I refer you to answer to XQ54.

XQ67. As the first sentence of that answer is confined to what is theoretically true, and the balance of the answer to the abnormal amusement flight, I will ask you if what you state to be theoretically true in your first sentence to answer to XQ54 accords with what would be generally true in actual practice?

A. I think I have answered that in my reply 464
to XQ57.

XQ68. You there in answer to XQ57 still confined your reply to what is theoretically true. Please state whether the same thing is practically true?

A. I am very sorry that I can't understand the question.

XQ69. Do you understand your own answer to direct question 36?

A. I understand exactly what I meant by it, yes.

XQ70. Do you understand the first sentence of your answer to XQ54?

A. I do. 465

XQ71. Does what you say in the first sentence of your answer to XQ54 apply in practice as well as theoretically?

A. Not so far as my experience has gone with the Government aeroplane Curtiss type which I have flown.

XQ72. Have you ever made the experiment of attempting to turn the defendants' machine to the right or left by setting the balancing planes so as to cause the main plane to tilt, so that one wing tip would be higher than the other, but with-

466 out moving the rear vertical rudder from central position?

A. Yes, I have tried this repeatedly, but have never succeeded in making the turn until another factor was introduced.

XQ73. What else did you move when you succeeded in making the turn?

A. My front horizontal elevator. The effect of this was to virtually make a vertical rudder of this front horizontal elevator, because I had already tipped the main planes to a steep banking angle which brought about this change of function of the elevator.

467 XQ74. Will you kindly answer cross question 72 without reference to the forward horizontal rudder alluded to in your last answer.

A. I can't answer the question without referring to the horizontal rudder. There is nothing to answer unless I refer to it.

XQ75. Well, did you ever make the experiment stated in XQ72 without resorting to any use of the horizontal rudder?

A. Yes, I have made such experiment, but so long as the horizontal rudder or the vertical rudder was not used, there was absolutely no turning tendency.

468 XQ76. Please state how long the experiment you referred to in your answer to XQ75 continued?

A. I have never made any definite experiments on this point, but I have had occasion many times to note the facts which I have just stated. If I understand your question properly, my answer to XQ54 and 56 should apply here. Although those two answers do not refer directly to a right and left deviation from a straight course, but relate to the other turning moment, namely, that one around the longitudinal axis of the machine.

XQ77. I understand your last answer to in ef-

fect say that theoretically the machine would turn 469
to the right or left under the conditions stated in XQ72. Is this correct?

A. It is not correct. So far as I am aware, there is absolutely no theoretical reason why this aeroplane should deviate to the right or left of a straight course, because of the use of the ailerons alone. The pressure on the top of one aileron is exactly equalized and neutralized by the pressure on the bottom of its mate. However, whatever the theory may be and whether or not those more expert than myself can find fault with this theory, the fact remains that practically I have never
found the slightest tendency to swerve to the right 470
or left of a straight course when the ailerons alone have been used. This refers to the nine different machines of the Curtiss type which I have flown.

XQ78. Have you ever noticed in defendants' machine, when the main planes were in a laterally tilted position, a tendency of the machine to move or slide toward the low side?

A. I did on one occasion when I had banked too steeply and was turning and climbing at the same time.

XQ79. Then you may state what you did to get out of that situation.

A. I plunged the nose of the machine downward, 471
banked sharply in a direction opposite to my original bank, and threw my vertical rudder in a direction directly opposite to the way it had been set on the turn.

Cross Examination Closed.

RDQ80. In XQ42 you were being questioned about the flights made by Mr. Curtiss with Lieutenant Ellyson as a passenger. In your answer you said:

"It is possible that had the object of

472 these experiments been to determine whether or not there was any divergence between the longitudinal axis of the machine and the course, I would now be in position to give definite testimony on that point. In other words, I paid no attention to this divergence."

Will you please explain what divergence you were then referring to?

A. I was referring to the constant divergence between the longitudinal axis of the machine and the course. Had there been any swaying of the
473 machine to the right and left in the horizontal plane, I would have noticed it, because such swaying could not have occurred without the machine leaving the line of the ground course.

RDQ81. Please state whether or not you were watching to see if there was any such swaying or movement of the longitudinal axis of the machine to the right or left during those flights?

A. Yes, I was watching that particular point in all of the flights, including those made by myself as a passenger. I saw no such swaying or movement of the longitudinal axis to the right or left of the straight course on any occasion during
474 these experiments.

RDQ82. In your answer to XQ53, in speaking of your trips as a passenger with Mr. Curtiss, you said:

> "It was perfectly practicable to feel the lateral deviation."

Please state what "lateral deviation" you were referring to?

A. I was referring to the tip or tilt of the aeroplane in the vertical plane, perpendicular to the longitudinal axis of the machine.

RDQ83. In that same answer you said that it

was practicable to "see the operation of the wheel 475
controlling the vertical rudder." In your testimony you have stated that this wheel was moved forward and back bodily to operate the front horizontal rudder, but that it was not moved rotatably at all. Did you by the above quotation mean in any way to change your testimony?

A. No, I simply meant that my seat was so located as to give me a clear and unobstructed view of the control wheel.

RDQ84. Roughly, how many flights in aeroplanes had you made, if any, previous to the time when you flew as a passenger with Mr. Curtiss, about which you have testified? 476

A. I had made one trip as a passenger in a Farman machine, two trips as a passenger in a Wright machine, two trips as a passenger in a Curtiss machine, and had made about fifty flights alone in a Curtiss machine.

RDQ85. In the Curtiss machine when equilibrium is lost and you desire to restore it by using the ailerons, how long do you have to use them to bring the machine back to horizontal?

A. The action of the ailerons is practically instantaneous. It is difficult to assign any definite period of time to an action of this sort, but I am inclined to think that a tip of as much as a foot 477
from the horizontal can be corrected in a tenth of a second.

RDQ86. That is, in your flights you consider that it didn't take you longer than that ordinarily?

A. Yes, that is my idea of the speed at which these ailerons act.

Recross examination:

RXQ87. In flying a machine of the defendants, which way do you turn the rear vertical rudder

478 when you want to go to the right, and which way when you want to go to the left?

A. I turn the control wheel to the right for a right turn, and to the left or counter-clockwise when I desire to make a left turn. The rear of the rudder turns in the direction in which it is desired to turn the machine.

PAUL W. BECK,
Capt. 18th Infantry,
U. S. Army.

Resumed at 2:30.

479 After Lunch.

CHARLES F. WILLARD, a witness introduced on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

> By Mr. Toulmin: I merely note on the record that the witness now called was not named in the notice.
>
> By Mr. Newell: You, however, do not object to his testimony at this time on that account, do you?
>
> By Mr. Toulmin: No, I do not, as to this
>
> 480 particular witness, but merely wish the record to show the fact stated.

Q1. Please state your name, age residence, and occupation?

A. Charles F. Willard, age 30, residence New York City, occupation, aviator.

Q2. Are you in the employ of Mr. Curtiss, or The Herring-Curtiss Company?

A. I am not in the employ of Mr. Curtiss or The Herring-Curtiss Company.

Q3. Did you at one time fly a Curtiss machine which was power-driven by an engine and propeller

and which had two curved main supporting sur- 481
faces, with a fixed horizontal surface and a vertical
rudder in the rear, and in front of the machine a
two-surfaced horizontal rudder, said machine hav-
ing slightly curved ailerons, one on each side of
the machine pivoted to the front posts about mid-
way between the main supporting surfaces, the ail-
erons being simultaneously rocked in opposite di-
rections by wires which ran to a laterally-movable
shoulder frame pivoted to the operator's seat,
neither of these ailerons being movable without
moving the shoulder frame, and in which the front
horizontal rudder was moved on its pivot by means
of a post movable back and forth and which was 482
by a bamboo rod connected to the horizontal rud-
der, the rear vertical rudder being operated by
wires which ran around a steering wheel pivoted
to that post?

A. I flew such a machine as described in Q3.

Q4. Roughly, how many times have you flown an aeroplane up to the present time?

A. It would be impossible to give an exact number of flights, but roughly speaking, many hundred flights have been made by me up to the present time.

Q5. About how long did you fly a Curtiss ma-
chine? 483

A. I flew a Curtiss machine for a little over a year and a half.

Q6. In your experience flying the machine mentioned in Q3, did or did not the ailerons, when used to restore lateral equilibrium, under any conditions, cause the machine to swerve or turn its longitudinal axis to one side or the other so long as the vertical rudder was held in a central position?

A. The use of the ailerons in the machine mentioned did not cause the machine to swerve in any manner whatsoever.

484 Q7. Have you, in any Curtiss machine which you have flown, ever noticed any tendency of the machine to swerve because of the use of the ailerons?

A. I have never noticed any turning tendency due to the use of the ailerons in any Curtiss machine I have flown, because there was no turning tendency to be noticed.

Q8. Please state the length of some of your longest flights, which you have made?

A. In a machine of the type mentioned in Q3, I have made numerous flights of over half hour duration, and many flights of over an hour duration, both in Aviation Meets and in cross-country
485 work. In the latter case in several instances flying over cities and totally unexplored country.

Q9. Will you please describe what experience you had, if you did have one, in which in this type of machine the vertical-rudder controlling wire broke?

A. While flying at an exhibition in Toronto, Canada, in the month of August, 1911, the rudder-controlling wires of my machine broke while in flight and they were not discovered by me as broken until I desired to return to the aviation field. Finding that I had no rudder wires I was obliged to fly straight ahead for approximately
486 two miles before I found a field of sufficient dimensions to allow a landing, without the use of a rudder. The country over which I was flying was very rough and considerably wooded, in addition to which there was a rather severe wind blowing, which necessitated the constant use of my ailerons for the purpose of maintaining stability laterally, notwithstanding the continuous use of the ailerons, I flew in a perfectly straight course, except for the side drift of the machine due to the wind. I noted this particularly, as after fixing the rudder wires I flew back to the field over exactly the same

ground which I covered with the disabled machine. 487
Further than this, in selecting the landing place while the machine was disabled by the loss of its rudder wires, I flew for probably a quarter of a mile lower than the tops of the trees over a piece of ground from which the timber had been cut, leaving nothing but stumps and on which it was impossible to land. Over this stretch of ground I was between trees the whole way.

Q10. In making this flight with the rudder-wires broken, did you, or did you not, have to steer the machine up and down, and, if so, please state about the distances the machine rose and fell?

A. In this flight mentioned, the rudder broke 488
when I was at an elevation above the ground of from 100 to 150 feet. In selecting a landing place, it was necessary for me to fly both up and down in order to clear trees and shrubbery and to land in the field which I finally selected.

Q11. Did your use of the ailerons in restoring equilibrium during this flight cause the machine to swerve or turn?

A. The use of the ailerons in this flight positively did not cause the machine to turn. Otherwise I would have fouled the trees which were on either side of me.

489

Cross examination by Mr. Toulmin:

XQ12. Did not your machine, while working to the ground after you had found the rear wires broken, make short zig-zags as the ailerons were operated from one position or another?

A. The machine did not zig-zag from side to side, for if it had I would have become entangled in the trees, in the first place, and in the second place I could not have landed in the field where I did eventually land, as this same field was quite narrow and I was parallel to, and within 50 or 100 feet of a stump-fence when I landed.

490 XQ13. I think you overlooked a feature of my question. I again ask you did not the machine make short zig-zags on that occasion, but getting back into line substantially what it lost by each zig-zag, so that the machine kept momentarily changing the longitudinal axis, first to one side and then to the other of the line of its general course, your quick manipulation of the ailreons bringing it back from one swerved position to another quickly enough to prevent going off into the trees. Is that not substantially what occurred with you?

A. My machine did not zig-zag from right to
491 left, either partly or wholly, and could not as there was nothing to make it do so, in the first place; and in the second place owing to the direction of the wind it was constantly necessary to move the ailerons in one direction, with hardly any movement at all in the opposite direction, and had the machine swerved the slightest particle when close to the ground and the fence, it would have been impossible to have accomplished a safe landing at the speed at which this machine travels, owing to the proximity of the before-mentioned fence and trees.

XQ14. In answering direct question 6 you stated
492 that the use of the ailerons in the machine referred to, so long as the vertical rudder was held in a central position, did not swerve in any manner. Is it your practice to always hold the rear vertical rudder in a central position while you are recovering lateral balance by the ailerons?

A. In flying in a straight line I never moved the rudder from whatever position it may be in while using the ailerons, and have flown between three and four minutes at a time with both hands off of the steering wheel entirely, during which time I used my ailerons.

XQ15. In your last answer you say you never moved the rear vertical rudder, when flying in a straight line, from whatever position it may be in while using the ailerons. Then is it true that the rear vertical rudder has sometimes been turned toward the high side of the machine and sometimes toward the low side during the period of recovering lateral balance? 493

A. I did not mean to imply in my last answer that the rear vertical rudder was either turned to the right or left, but merely to state that I did not move the same when using my ailerons, and assumed that it was in a normal position.

XQ16. As your answer seems to be based on my use of the word "turn" in the last question, I will ask you the same thing in another form. In answering XQ14 you say while flying in a straight line you never moved the rudder from whatever position it may be in while using the ailerons. Then is it not true that the rear vertical rudder may happen to be standing over toward the high side or over toward the low side of the machine at the time of manipulating the ailerons to recover lateral balance? I ask this because you state, that you operate the ailerons when the rudder is in whatever position it may happen to be in. 494

A. The rudder might be slightly to either side due to a prevailing side wind, but would be substantially neutral insomuch as its movement in either direction would cause the machine to turn from left to right, and consequently to make the answer to your XQ14 more explicit, I will say that I do not move the vertical rudder from its normally central position while using the ailerons for lateral balance. 495

XQ17. But suppose the rear vertical rudder happens to be turned to one side of the central position, at a time you operate the ailerons to recover

496 lateral balance. Do you under such circumstances allow the rudder to remain in such side position?

A. If the rudder were in such a position as you assume, and the machine were flying in a straight line, and it was desirous of maintaining such a straight line flight, then insomuch as the use of the ailerons do not change the line of the flight from right to left, I should leave the rudder in such position as assumed that it was in regardless of how much I used the ailerons.

XQ18. And therefore it sometimes happens that the rear vertical rudder may be turned to either
497 side of the central position, as it might happen, when the ailerons were adjusted to recover lateral balance?

A. You assumed in XQ17 that sometimes the rudder might be turned slightly either to the right or left and I answered accordingly, but in flying in a substantially straight line the rudder would necessarily be substantially neutral; otherwise the machine would turn to the right or left, and therefore I will say that the rudder could not be turned to the right or left and a flight in a straight line be maintained.

XQ19. My reference in XQ17 to the side posi-
498 tion of the rudder was based upon your answer to XQ16, in which you stated the rudder might be slightly to either side due to a prevailing side wind. I therefore again ask you if may not happen and does happen, that the ailerons are adjusted to recover lateral balance while the rear vertical rudder may be turned to one side or the other of the neutral position when the machine is flying in a substantially straight course, such position of the rudder being due to a prevailing side wind. Is not this substantially correct?

A. The rudder being no factor whatsoever in the

movement of the ailerons, it may be in any posi- 499
tion whatsoever when the ailerons are operated, neither necessitating any attention being paid to the other at any time.

Adjourned at 4:30 P. M. to to-morrow, Sept. 22nd, at 10:30 A. M. same place.

New York, N. Y., Sept. 22, 1911,
10:30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

XQ20. In answering XQ13 and in speaking of 500
why the machine did not go out of a straight course or zig-zag, you said, "In the second place owing to the direction of the wind it was constantly necessary to move the ailerons in one direction, with hardly any movement at all in the opposite direction." How did this keep the machine straight ahead notwithstanding the direction of the wind?

A. The use of the ailerons had nothing whatsoever to do with the direction of flight, and in a previous answer I believe I made mention of a side drift to the machine due to the wind. 501

XQ21. Then by what means did you keep the machine in the straight course, as you say, except for the side drift due to the wind as stated in answer 9?

A. I had absolutely nothing to do with the direction of flight of the machine, except in ascending or descending, and it maintained its original direction, with the exception of the side drift, until I landed.

XQ22. Was the wind blowing at an angle to the course of the machine so that it met the machine partly to one side and partly in front?

502 A. The direction of the wind might be described as suggested by your XQ22.

XQ23. And would not the effect of such a course of the wind be to tend to lift that side of the aeroplane or machine which might be called to windward?

A. Such a course of the wind would probably, in a majority of cases, cause a lifting action on the windward side of the machine.

XQ24. And that was true during this flight in question because of the conditions you have stated as to the wind, would it not?

A. Not necessarily at all times, though with the
503 majority of the time, yes.

XQ25. And to counteract the tilting effect thus produced, you set the ailerons at the leeward side of the machine at the greater or lifting angle, did you not?

By Mr. Newell: Counsel is requested to make his expression "greater or lifting angle" clear. The greater angle, if any, is not necessarily the lifting angle unless counsel means to join the two in the question. I make this request because the question as put is not fair without this
504 information.

By Mr. Toulmin: The Court will again note that at critical times in the cross examination such objections as the one above have been interposed again and again. The purpose is obvious and the witness will please answer the question.

By Mr. Newell: The objection is made in good faith and the ambiguity in the question is obvious. I do not propose to have you ask misleading questions, without explanation.

By Mr. Toulmin: My statement above 505
is repeated with emphasis.

A. To counteract this tilting effect the ailerons on both sides of the machine were changed simultaneously and momentarily, the aileron on the leeward side tending to raise that side while it was below normal, and the aileron on the windward side tending to bear down with equal force on the windward side which we assume was above normal.

XQ26. And another effect of this wind in that flight was also to cause the machine to travel
with its longitudinal axis swerved or swung to 506
one side of the actual course, the machine was bodily moving, did it not?

A. There was no swerving of the machine as I interpret the word "swerve," the machine maintaining its line of flight in a perfectly steady forward line, except that it moved bodily toward the leeward.

XQ27. Well, was not the longitudinal axis of the machine at an angle to the course the machine was bodily moving?

A. It would seem to me that this would be the case.

XQ28. And during that time do you know what, 507
if any, effect or action the ailerons, being adjusted as you have stated, had in preventing the further swinging of the longitudinal axis of the machine from the line of its general course?

A. I know quite positively that the action of the ailerons could neither prevent nor assist the swinging of the longitudinal axis from its general course.

XQ29. Then why did not the longitudinal axis of the machine swing further around to a greater

508 angle to the general course of the machine, as a consequence of the lifting and turning effect, as you have stated, of the wind?

A. I have not stated that there was any turning effect due to the wind, but have stated quite positively that the machine drifted bodily sideways, and I can see no reason why the machine should turn from its course, as you state, there being nothing apparently to make it do so.

XQ30. But in answering XQ27 you stated, when asked was not the longitudinal axis of the machine at an angle to the course the machine were bodily moving, that "it would seem to me that this would
509 be the case." In view of that answer will you not kindly now answer the last preceding question?

A. Answering your cross question 29 again, I must say as before that while the machine would move at an angle to the longitudinal axis, there was nothing to cause it to turn from the straight line of the longitudinal axis, which if imagined extended, forms the line of flight, the action of the wind, as I said before, merely causing the machine to move bodily sidewise.

XQ31. To which side of the general course of the machine did the longitudinal axis of the machine turn, speaking of the front end of the axis,
510 that is, did it turn toward the wind or from the wind?

A. The longitudinal axis of the machine did not turn at all, neither towards or away from the wind. It moved bodily sideways with the machine, the original position of the longitudinal axis and the final position forming approximately the two opposite sides of a parellelogram.

XQ32. Assuming your last answer to be correct, namely that there was no swerving or turning of the longitudinal axis of the machine, to an angle to the general course of the machine, what

was there that counteracted the effect of the wind 511
to produce such a turning of the longitudinal axis in connection with the tilting effect of the wind?

A. There was no turning effect in a longitudinal axis due either to the wind or the tilting, and nothing to counteract it if such an impossible thing had occurred.

XQ33. I believe you stated in your direct examination that this machine with which you had this accident was of the Curtiss type. Is that correct?

A. Yes, this machine was a Curtiss type machine, differing only in the engine, which was a foreign make.

XQ34. Was not that particular machine the 512
one illustrated in the publication called Aeronautics for August, 1911 and described and illustrated at pages 48 and 49?

A. Positvely no, this machine mentioned by you and shown and described in this magazine was a new machine of my own type built solely for experimental purposes and at the time of the flight referred to previously, it was not completed, the parts being in New York while I was in Canada in the flight mentioned. Further than this this machine has never been used in public demonstrations and was absolutely demolished beyond repair in
a secluded field on the second day of my experi- 513
ments with the thing.

XQ35. Then you will please describe exactly the construction and arrangement of this machine which you were in which you had the accident of the wires breaking?

A. The machine in which the accident occurred was of the Curtiss type, having a front and rear control with bamboo outriggers as used in all Curtiss machines, the rudder mounted on the rear fixed surface, the running gear and control being

514 identical in every way with the standard Curtiss machine.

XQ36. Did one or both of the vertical rudder wires break?

A. The rudder wire broke at its central point where it passes over the steering wheel, in such a manner that both commanding wires to the rudder were loose, ineffective and uncontrollable by me from the seat.

XQ37. In your testimony yesterday you stated that the rudder wires broke without your knowledge, or that you did not discover the fact until you wished to make a turn so as to go back to the
515 aviation grounds. You now say the wire parted at a point on the wheel, which was of course immediately in front of you. Did you not therefore, as you now recall the circumstance, discover the breakage at or about the time it took place, and did not the dropping of the wires from the wheel attract your attention?

A. I am not in the habit when flying of looking at these wires, as they are in a groove in the wheel for the short distance that they are visible, and after leaving the lower side of the wheel which I could not see, they followed down through the steering post, which is tubular, to a point which
516 I could not see without great exertion. In fact in this particular case I remember distinctly that as soon as I discovered the loss of command of the rudder, I looked as far as possible to discover the exact point of breakage and to ascertain to what extent of immediate danger I was in, but owing to the construction of the steering gear I was unable, until after I had landed, to locate exactly where the disarrangement had occurred.

XQ38. But in answer to XQ36 you said the "rudder wire broke at its central point where it passes over the steering wheel." This central point is

substantially at the top of the wheel when the 517
rudder is in a central position, is it not?

A. Yes, this is so.

XQ39. And in that machine this wire was wound around the wheel twice before parting from the wheel, was it not?

A. In this particular instance, as I remember it, a new wire had been inserted through the steering post and around the wheel and back to the steering post, etc., by my mechanics, but owing to a lack of supplies in this instance, there was but one wrapping around the steering wheel and several tacks had been driven into the wire to hold it
from slipping in the groove. All of these tacks 518
had been driven at approximately the center, with the result that they had no hold in the wood and fell out, so far as I know even before I started flying. Further than this, the actual cause of the breakage of the wire was due to the fact that these numerous tacks had cut the wire at this point, leaving probably only one or two strands intact, this steering wire being made up as a whole of several small strands.

XQ40. The groove in the wheel in which the wire lay would be covered by your hand in holding onto the wheel, would it not?

A. Sometimes yes, and sometimes no, as I fre- 519
quently operate the machine by holding the spokes of the wheel and many times by pinching the steering post tightly between my knees. At other times I hold my hand either right or left, at whatever position I find for the moment most comfortable, but under no condition do I ever make it a practice to grip the wheel tightly, except in turning.

XQ41. So that in all of these cases you have named, either your hands, one or both, or your knees, would be in close proximity to the wire in the groove of the wheel rim?

520 A. My hands might be in proximity with the wheel, but my knees would at no time be in proximity to the wires, as at the point where my knees would come in contact with the steering post, the wires would be inside of the same.

XQ42. And do you wish to be understood as saying that this steering wire parted at a point on the wheel and got down into the steering post without your seeing that something had happened, or that the wire was loose?

A. Yes, this wire broke and slid into the steering post without my knowing it, due probably to the fact that my attention was attracted to the ground
521 over which I was flying, and also to the fact that there may have been quite some time between the breakage of the wire and the time when I decided to turn around, I having flown possibly a mile over what open territory was before me, before deciding to return to the aviation field. Further than this, I had on a stiff pair of driving gloves and the groove in the wheel being at least a half inch deep, the wire could easily have parted at almost any time without my knowing it.

XQ43. As a pull on one branch of the wire, between the rudder and the point of attachment to the wheel, say by any movement of the rudder by
522 wind gust or such a matter would slacken on the other branch of the wire, how do you account for both branches being drawn back into the tubular post?

A. Where the wires leave the bottom of the tubular post, they are at almost right angles to the line of flight for approximately four and a half feet on either side of this post, and at approximately fifty miles an hour the pressure alone on these short lengths of wire is more than sufficient to account for their being drawn down into the post.

XQ44. Do you mean to say that the pressure 523
comes on both branches of the wire at one time, instead of coming on one wire at one time and the other wire or branch at another time?

A. In answering your previous question I was accounting for the both wires being drawn into the tubular post, and the only pressure to be taken into account when the machine is flying straight ahead and the rudder in a neutral position with no strain upon it, is the pressure exerted on the wires due to the forward velocity of the machine. This pressure which I am referring to is, within all practical limits, the same on both wires.

XQ45. Then you are claiming that when the 524
rudder was not being operated by you, there was tension enough on both branches of the wire to break it at the point on the wheel where it was attached to the wheel, and notwithstanding that the wire circled the groove of the wheel once, or possibly twice? Is that your position?

A. I do not know when these wires broke; otherwise I might have been able to catch at least one end. It may be that the wire broke when I attempted to turn the machine. Even if it had broken at this moment, before I realized that the wheel was useless, the wires had dropped into the steering
post before I landed, or even before I noted just 525
where the break had occurred. I have stated specifically that in this particular instance there was only one wire passed over the top of the wheel and held from slipping by one or more tacks. Further than this, upon landing the wire was broken where it had been tacked and the tacks were missing. I did not know, until after I had landed, exactly where the break had occurred. I do not claim that there was tension enough on these wires, or that there was not tension enough on them, to break the wire, but only endeavor to account for

526 their being drawn into the steering post by this tension, which was more than sufficient for the purpose.

XQ46. And how long was the steering post from its upper to its lower end where the wires entered and passed out?

A. I don't know absolutely this dimension, but I should say about 18 to 20 inches, possibly more.

XQ47. And from the upper end of this hollow post to the point on the wire when the breakage took place, near the top of the wheel, what was the distance or length of such part of the wire as to each branch from the post to the wheel?

527 A. Possibly one foot on either side.

XQ48. By "possibly" you mean approximately, if each branch went direct from the top of the post to the top of the wheel?

A. Approximately is correct, and the wires did go direct from the top of the wheel to the post.

XQ49. And you have stated that each branch of the wire from the lower end of the hollow post to where it turns and goes rearward on the machine is approximately four and a half feet. Was that correct?

A. The wire does not go directly rearwards, as stated before, but at a very obtuse angle and is
528 approximately four and a half feet in length on each branch.

Adjourned for lunch at 1 P. M.

Resumed at 2 P. M.

XQ50. Then there was a stretch of about seven feet on each branch of the broken wire from the end of the branch back to the guide on the supporting frame at or near where the wire entered the bamboo tubing. Is that substantially correct?

A. Yes, that is substantially correct.

XQ51. And after you discovered the breakage in the wire, do you say that you had no opportunity to take hold of either or both of the broken branches, seeing that they had to pull away from the wheel, back out of the hollow post and get out of the guide pulleys or sheaves between the foot of the hollow post and the entrance to the bamboo tubing? 529

A. There was no opportunity to reach the wires from the seat after breakage. I would like to have it understood that these wires did not drop out of the hollow post and fall free. The frayed ends, I believe, held the wires inside of the post, although as a matter of fact after discovering the break upon 530 the ground and instructing my mechanics to put in a new wire, I paid no further attention to the machine until it was ready to fly back.

XQ52. How close to the seat on which you sat was the lower end of the hollow post out of which the wires extended?

A. I should say about two feet.

XQ53. In front of you?

A. In front and below, even below the foot rest.

XQ54. And how far were these broken wires, at the point near the foot of the hollow post, from the seat?

A. I said in answer to XQ52 that they were about 531 two feet in front of the seat.

XQ55. Could you reach from the seat down to where these wires were and take hold of them?

A. Positively no.

XQ56. Could you shift forward in the seat and otherwise reach out and take hold of these wires, or either of them, at the point near the foot of the hollow post?

A. It would have been impossible to have changed my position in the seat in any manner to a sufficient extent to allow me to reach these wires

532 without losing control of the machine absolutely. I doubt very much if I could even have touched the wires with my foot. At all events I did not try, as I was afraid of further disturbing the wires and having them become entangled in the propeller.

XQ57. But did not the bamboo tubes enclose the rudder wires to a point both forward and rear of the plane of the propeller?

A. The wires in question are not inside of the bamboos which support the rear elevator, but these wires are supported in small tubes which are affixed to the bamboos. This in no way protects the propeller from the two sections of wire which I have
533 already mentioned as running from the bottom of the steering post back to the beginning of the bamboo and which we have assumed were seven feet long each. Had these wires dropped out of the steering post, the wind pressure would have blown them into the propeller, the result of such a thing almost invariably proving fatal.

XQ58. How many turns or bends were in each of these wires, counting from and including the bend at the foot of the hollow post onto the rear ends of the wires where they connected with the rudder?

A. Including the turn over the pulleys at the foot
534 of the post, there are three turns or bends in each wire.

XQ59. Was it due to the friction of the wire with these points of contact at these bends or turns, that caused the wires to remain at their forward ends still within the hollow post?

A. The bends all being outside of the post, could have had nothing to do with the wire remaining in the post.

XQ60. Well would not the friction at those points along the wires have kept the wires from

working backwards and in that manner preventing 535
the wires from pulling out of the hollow post?

A. Regardless of the amount of friction on these bends, except the one bend at the bottom of the post, the wires would still have pulled out. As a matter of fact this form of steel wire being more or less stiff and springy, tends to straighten itself out when the ends are free, and the only bending point of any consequence was at the foot of the steering post as mentioned before. At this place the wires pass over pulleys which make their movement through the post very free. The bends or turns of the wire along the bamboo could have nothing to
do with the wire pulling out of the steering post in- 536
somuch as the exposed part of the wire was forward of the bamboos.

XQ61. Well then to what cause do you attribute the forward ends of the wires remaining in the hollow post?

A. I have never given this any particular consideration, but would assume from my experience with this class of wire cable which, as I have stated before, is composed of numerous strands, that after breaking, some of the strands in each of the wires unravelled and stuck in the steering column somewhere between the top and the bottom.

XQ62. I wish you would locate exactly the field 537
into which you have testified you descended with the machine on that occasion?

A. This field is about eight miles outside of Toronto, Canada. I believe it is on the C. T. R. Railroad, although I am not positive of this.

XQ63. When you say Toronto, do you mean the aviation field where you were exhibiting at that time?

A. I mean that the aviation field where I was flying at that time is, I should say, eight miles outside of the City of Toronto, Canada.

538 XQ64. And how far from the aviation field was this particular field where you landed in the machine after you found that the wires were broken?

A. I believe I have stated in the previous answer that I was a mile or two miles from the field when landing. I have no way of knowing the exact distance as the country was strange to me and, at that particular time the distances were of no consequence.

XQ65. Well as you flew back from the same field to the aviation grounds, you went over the same course twice. For this reason I will ask you to locate the direction of this outside field from the
539 ground?

A. It would be absolutely impossible for me to tell whether the field was north, south, east or west, as I had no knowledge of the country and no occasion to look up or remember the compass points in that locality.

XQ66. And so you do not know in which direction you were flying when you discovered, as you have stated, that these wires were broken?

A. I have absolutely no knowledge of the compass direction of my flight at that time. I can only state that I flew directly away from the aviation field and the railroad tracks, which ran along one
540 side of the aviation field, and that after repairing the machine, flew directly back. I did not land immediately. In fact I circled around the immediate neighborhood of the aviation field several times, and after landing gave the matter no further consideration.

XQ67. Do you mean that you flew away from the railroad tracks, or about in line with those tracks?

A. I flew away from them at approximately right angles to them.

XQ68. Did you learn the name of the owner of the field where you aligned? 541

A. I did not learn the owner, or see the owner, to my knowledge.

XQ69. Was there a road or pike bordering this field on either side of it?

A. I believe there was a road on one side of the field, but the road was not visible from where I landed owing to the high trees. My mechanics came to the field in an automobile, although I did not see the machine, and consequently there must have been a road somewhere in the neighborhood.

XQ70. And are those mechanics, or all of them, still working for you, or Mr. Curtiss, or the 542
Herring-Curtiss Company?

A. None of the mechanics I had at that time are working for any of these people you mention. One of the mechanics referred to was a subsitute, my regular man having been in New York looking after the machine which you mentioned this morning as being described in the magazine. It is very possible that one or two of these mechanics will be employed by me in the near future.

XQ71. How many of these mechanics were there, including the substitute?

A. I had three men with me including the substitute. 543

XQ72. Will you give me the names of each of these men and their present addresses?

A. I can give you the names of the men, but as they are all out with other machines on the road, I cannot give you their addresses either present or permanent. The men were R. W. Fagan, W. H. Willard and W. Itell, the latter being the substitute.

XQ73. With what make of aeroplane, or by what name known is each of these men at this time con-

544 nected with or employed in the capacity of mechanical attendant?

A. I don't even know positively where two of them are.

XQ74. Which two?

A. Fagan and Willard, but I believe Fagan is with Mr. Ward who is operating a Curtiss machine, and that W. H. Willard is in Harrisburg, Penna. with the Curtiss type machine, which belongs to a party by the name of Tickell. I believe that Itell is employed by Mr. McCurdy at the present time.

XQ75. You mean the Mr. McCurdy who is present here in the room and has been for the last half
545 hour or so?

A. I do.

XQ76. Did this accident to your machine occur on the first or second or what day of the meet and what day of the month?

A. I don't remember what day of the Meet or day of the month this occurred. I can simply say that it was in August, 1911.

XQ77. From your remark you made yesterday I judge you were in a highly nervous and disturbed state when you discovered that these rudder wires had departed from the wheel. Will you please state your mental condition and degree of agitation from
546 that time on until you landed?

A. I cannot say that I was agitated unduly, or more than such circumstances warrant. I might explain my mental attitude by stating that I was in an extreme hurry to find a landing place before anything further occurred.

XQ78. And in a heavy nervous perspiration when you alighted from your machine, I understood you to tell me yesterday. Is that correct?

A. I don't remember testifying that I was in a state of nervous perspiration, although I believe that in talking of the case casually with you I used the phrase more or less figuratively.

XQ79. Well you volunteered this statement yes- 547
terday. I wanted to know now whether such was the fact?

A. It would be impossible for me to state whether I actually perspired or not. As I said before, in speaking of this matter in a general way I used the speech figuratively.

XQ80. Well now to be perfectly candid, were you not during the few moments from the time you discovered the broken wire until you got to the ground, in a state of alarm and anxiety with the chief thought on your mind that of finding a landing place before you would come to any disaster?
Is this substantially correct? 548

A. As soon as I discovered the difficulty with the rudder control, I was quite agitated until I became sure that there was no immediate danger of the wires which were broken becoming entangled in the propeller. From that time on until I landed it was merely a question of finding a field long enough in the direction of my flight to allow me to land, and I do not believe that there was any undue agitation on my part during the latter part of this flight, especially as I was obliged to use extreme care and judgment in making a landing, which I did. From the time that I discovered the difficulty with these
wires until I landed, I probably was in the air a 549
minute, or possibly two.

In order to accommodate the witness, who has to catch a train for the aviation field, adjourned at 3.35 P. M., to resume at 10 A. M., Sept. 23rd, same place.

550 New York, N. Y., Saturday, Sept. 23, 1911.

Met pursuant to adjournment.

Present—Counsel as before.

By Mr. Newell: The witness, Mr. Willard, has just telephoned me that it will be impossible for him to be here this morning. He told me yesterday in the presence of Mr. Toulmin that he would have to get off at one o'clock to-day because he was going in the Aviation Meet at Nassau Boulevard which opens this afternoon. I fully expected him here this morning, and as Mr. Toulmin said
551 yesterday that he would take probably all today with the witness on the cross examination, I let another witness go who I expected to put on, and none of my witnesses are now available. I believe that Mr. Willard cannot come this morning because he has to fulfill his contract to fly this afternoon, and has been unable to get a machine to fly in. I regret exceedingly that I have no witness here to take his place.

By Mr. Toulmin: The witness, Mr. Willard was accommodated yesterday by an adjournment at 3.45 P. M. upon his promise to re-
552 turn here this morning a half hour earlier than usual, namely 10 o'clock so that he might be examined until one o'clock, which latter hour seems to be the usual time of adjourning on Saturday in New York, even at this time of the year. It was therefore Mr. Willard's duty to return this morning as he promised to do. It must be understood that delays in getting the witnesses or in their refusal or failure to come at the time appointed, will not be accepted as an excuse or

extension of defendant's time. It is utterly 553
unjust to complainant to be delayed in this manner by the unwillingness of a witness or witnesses to properly attend, Mr. Wilbur Wright and his counsel both being here, under notice, in the city for the special purpose of attending the taking of these depositions.

By Mr. Newell: I explained the matter to Mr. Toulmin while Mr. Willard was on the phone and requested Mr. Toulmin to grant the witness an excuse for this morning, but Mr. Toulmin declined to do so. I regret ex-
ceedingly that we will lose this half a day, 554
but as we have almost every day commenced before, and taking testimony beyond, the time usually taken in this City for taking testimony, it does not seem to me that delay should be very seriously attributed to defendant.

By Mr. Toulmin: I do not know how short counsel thinks sessions ought to be under any custom in this City, but the record so far shows that the sessions held have not been as long as is the custom in almost every City of which I have any knowledge, and I
have taken depositions pretty well over the 555
country.

Adjourned to 10 A. M., Monday, Sept. 25th, 1911.

556 New York, N. Y., Sept. 25, 1911,
10:00 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

By the Witness: I came to New York
from west of Chicago for the sole purpose
of securing a machine, mine having been
demolished in an accident, and flying at
the International Aviation Meet at Nassau
Boulevard, which started Saturday, Sep-
tember the 23rd (the day before yesterday).
557 As all the available machines of the type
to which I am accustomed, the owners
and operators as well, being at Nassau
Boulevard, it has been impossible to see
any of them, or accomplish anything in
the way of securing a machine, without
going to the grounds personally. I did
everything within my power to make the
necessary arrangements by telephone and
indirect communication, but finding this
impossible at the last moment, I was
obliged to go in person to Nassau Boule-
vard Saturday morning. I offer apologies
558 to any who have been inconvenienced by
my non-appearance Saturday morning.

XQ81. Did you have a Gnome engine on the aeroplane you were flying at the time of the accident of the broken wire?

A. Yes, this machine was equipped with a Gnome motor.

XQ82. About what was the weight of that engine?

A. I have never weighed the Gnome engine per-

sonally, but I believe that the weight as specified 559
in the catalogue is 176 pounds.

XQ83. And the one you were using at that time was substantially that weight?

A. The motor I was using at that time was substantially that weight.

XQ84. And it drove a single propeller from about 1000 to 1200 revolutions per minute, did it not?

A. This is substantially correct.

XQ85. And this Gnome engine constitutes in effect while in operation a heavy revolving mass, does it not?

A. While in operation this motor constitutes a 560
revolving mass, but of only approximately one-third to one-half of the weight of the motor.

XQ86. Whose make was the machine you used on that occasion?

A. The machine that I used on this occasion was built by myself, for the reason that I wanted a machine slightly stronger than Mr. Curtiss could supply from his stock parts at the moment when I required this machine, but was authorized by Mr. Curtiss at Fresno, California, as substantially the machine which I was to fly under my
contract with him, and has always been known 561
as a Curtiss machine.

XQ87. Kindly state the different Meets, or places by name of location and date, where you used that machine in exhibition flights?

A. It would be quite impossible for me to give the dates and the different places where I used this machine, and I may even overlook some of the places entirely, but to the best of my ability the following list constitutes the places at which this machine was used—

By the Witness: I object answering this

562 as it is a personal matter, and there are many reasons why this testimony is detrimental to my business. These people in many instances will require machines at other dates and I feel entitled to this knowledge exclusively.

The first flight with this machine was made in Los Angeles, Cal., in December, 1910; Fresno, California, January, 1911; Los Angeles, Cal., December, 1910 and January, 1911; San Francisco, California, January, 1911; Salt Lake City, Utah; San Bernardino, Cal.; San Jose, Cal.; Sacramento,
563 Cal.; Salt Lake City, Utah; Provo, Utah; Boise, Idaho; Idaho Falls, Idaho; Walla Walla, Washington; Kansas City, Mo.; Keokak, Iowa; Columbia, Missouri; Attica, Indiana; Owensboro, Kentucky; Hamilton, Ontario, Canada; Toronto, Ontario, Canada; Utica, New York; a town in New York State where I sent the machine with an operator, the name of this town I am not sure of. The machine was demolished at this place and no longer exists. This machine was wrecked somewhere between the first and seventh of September, 1911.

XQ88. And Mr. Glenn H. Curtiss, or The Her-
564 ring-Curtiss Company, or The Curtiss Exhibition Company, either or all were interested with you in the proceeds of the flights made at the places made, were they?

By Mr. Newell: The question is objected to as evidently attempting to pry into the affairs of the witness under the guise of cross examination. This is improper cross examination, as nothing of this sort was gone into on the direct, and the witness is instructed that until other-

wise ordered by the Court he need not 565
answer the question.

By Mr. Toulmin: If the witness follows the advice of his counsel and refuses to answer the last question and any others germane to that subject, notice is given that the Court will be asked to disregard the entire deposition.

A. I became a witness in this proceeding with
the understanding that I was to testify as a
mechanical engineer and expert on aeroplanes,
and I object to answering this question unless
the Court orders me to do so, insomuch as 566
XQ88 deals entirely with a personal matter and
has no bearing whatsoever, so far as I can interpret it, upon the manipulation or mechanical points of aeroplanes or aeronautics.

By Mr. Toulmin: The notice above given is repeated, but without waiving the matter, the cross examination is proceeded with.

By Mr. Newell: I believe that the witness is entirely within his rights in declining to answer. I suggest that the
procedure in this Circuit is to certify the 567
record of the Court for it to determine
whether or not the witness should answer. I will welcome any such certification and motion.

By Mr. Toulmin: I do not propose to interrupt the proceedings and delay the case and add expense in order to go to Court any or every time opposing counsel may interpose advice to the witness not to answer. The other remedy indicated in my notice is sufficient, in this instance at least, and leaves the responsibility with the counsel to advise the witness.

568 XQ89. In answering direct question 5, you stated you flew a Curtiss machine for little over a year and a half. Please state whether that was under a contract for a division of the proceeds between you and Mr. Curtiss, or The Herring-Curtiss Company, as to any or all that period?

> By Mr. Newell: This question is objected to for the same reasons as the preceding one. Nothing of this sort was gone into on the direct, and it is manifestly improper cross examination for a
> 569 party to endeavor to prove his own case at the expense of his opponent, under such circumstances. The witness is therefore instructed that he need not answer the question until otherwise directed by the Court.
>
> By Mr. Toulmin: The notice above given is repeated, and it will be understood as repeated after each similar instruction to the witness. It is obvious that the questions which are not being answered, are directed to show the interest of the witness and his relation with one or both of the
> 570 defendants.
>
> By Mr. Newell: The question is not framed in that way, and the instruction is repeated.

A. I object to answering this question from the same basis that I objected to answering XQ88, but will state, however, that I had an agreement with Mr. Curtiss, The Herring-Curtiss Company, or The Curtiss Exhibition Company—I positively do not remember which of these three—this agreement covering a period of one

year, expiring in January, 1911, the exact date 571
of the expiration I do not know.

XQ90. And that was a contract for a division of the proceeds of your flight with the other party to the contract, was it?

> By Mr. Newell: Objected to for the same reason, and for the additional reason that complainant has no right to go into the details of the contract, and the same instruction that he need not answer, is given to the witness. Further, The Curtiss Exhibition Company is not a party
> to this suit. 572

A. I don't remember the wording of this agreement or contract, and don't know whether or not it could be construed in that way.

XQ91. But I did not ask you for the wording of the contract, but merely for its effect as to the question of division as to proceeds?

> Same objection and instructions.

A. I paid for the use of the machine, but object to going further into the details, unless so ordered by the Court.

XQ92. And since the expiration of that con- 573
tract, you have continued to fly for exhibition purposes and for prize or other money, have you not?

A. I object absolutely to answer this question in any dimension, unless so ordered by the Court, as it has absolutely no bearing upon my association with Mr. Curtiss, The Herring-Curtiss Company, or The Curtiss Exhibition Company, and I feel that questions along this line are an imposition upon the part of the attorney and are made for the purpose of getting information which might possibly have bearing on some other matter other than the case in hand.

574 XQ93. And after the expiration of that contract did you use for exhibition purposes a Curtiss type of aeroplane flying machine?

Counsel for defendants objects to the question for the above reasons, unless limited to the machine inquired about on the direct.

By Mr. Toulmin: In answering direct question 5 the witness spoke of his flying "a Curtiss machine". In direct question 9 he was asked for his experience "in this type of machine." It is therefore compe-
575 tent to ask the present cross question and an answer is requested.

By Mr. Newell: That question (Q9) was only in regard to Mr. Willard's experience when the rudder wire broke.

By Mr. Toulmin: The question is also competent as testing the interest of the witness.

A. The machine in question, that is the machine on which the rudder wire broke while flying in Canada, was a Curtiss type aeroplane but built by myself as and for the reasons described in my answer to XQ86.

576 XQ94. Then it is true that from the expiration of that contract which has been referred to, you have continued to use for exhibition purposes a Curtiss type of aeroplane flying machine?

A. I object to making reference to the different types of machines, if such they were, except in the case of the specific machine referred to in the Canadian flight, but will add that I have practically adhered to this type of machine exclusively in my exhibition work.

XQ95. Are you also engaged in the manu-

facture and sale of such type of aeroplane flying 577
machine, either alone or in association with Mr. J. A. D. McCurdy, as referred to in the copy of Aeronautics for August, 1911, at page 48?

Counsel for Defendants objects to the question as outrageously outside of the matters at issue, and not proper cross examination, as the article referred to does not mention in any way any of the parties to this suit. The witness is instructed that he need not answer the question. The question is obviously, in my opinion,
as well as this line of examination, per- 578
sisted in, not for the purpose of this suit, but for some other purpose.

By Mr. Toulmin: Again complainant insists upon the right to test the self-interest of the witness as affecting the credibility of the deposition.

By Mr. Newell: That does not entitle you to go into matters outside of the case.

A. I refuse to answer this question in the form in which it now exists, but if it is as you state in the previous sentences your desire to show my self-interest in this case, I will state for your benefit
and the benefit of the court that I am negotiating 579
with two firms at the present moment for a position with each in the capacity of designing mechanical engineer on automatic machinery, and at the present moment doubt very much if I will be interested or associated with aeroplanes for any longer than such time as it will take to fill my obligations in this industry.

XQ96. So that your refusal to answer the questions above has been based upon your past relations with others and on your own account in connection with giving flight exhibitions for money, 580 rather than because of your now expected future continuance in such exhibitions. Is that substantially correct?

A. My objections to answering your questions have been based upon the facts that I was called as a witness in the capacity practically of a mechanical engineer and aeroplane operator, and not to testify as to my financial gains or losses due to my association with the aeroplane industry. I will not be misunderstood in my last answer to state that I am positively resigning from the aeroplane industry immediately. The matter depends entirely upon satisfactory arrangements being com-
581 pleted with either of these two concerns mentioned, or any other concern. The fact however remains that I am quite desirous of resigning from the aeroplane business, either in part or fully.

XQ97. In the same issue of Aeronautics at page 48, issue of August, 1911, reference is made to the McCurdy-Willard Aeroplane Company as in the business of giving exhibitions. Are you the Willard referred to there?

A. I object absolutely to answering this question, and again state to the court that it is my personal belief that the attorney questioning is taking advantage of an opportunity to gain information to
582 be used for purposes other than in this case.

By Mr. Toulmin: The witness is mistaken in his assumption, for such is not my purpose.

XQ98. Is the McCurdy-Willard Aeroplane Company a corporation, and if so, under the laws of what State?

By Mr. Newell: Same objection and instructions to the witness that he need not answer if he doesn't wish to.

A. That is a matter of record and will show on the books if the company you mention is incorporated. 583

XQ99. Well, do you decline to answer my last question?

A. I will positively decline any and all questions that do not have bearing upon the direct questioning in this case.

XQ100. You are assuming to act as judge and to say what questions are proper and what are not. In doing that you have failed to answer XQ98. Will you now do so one way or the other?

A. I have objected to answer partially upon the advice of Mr. Newell and partially for personal 584 reasons. In most cases I have specifically stated that I refuse to answer unless directed to do so by the Court, and in the event that I have neglected to use this phrase "unless directed to do so by the Court" in any of these refusals, I add herewith that I will gladly answer either these questions or any others that the Court may desire to ask me, and will endeavor when so asked by the Court to tell absolutely the facts truthfully and to the best of my ability.

XQ101. I have no doubt you would answer such questions as the Court might direct you to answer, because your failure to do so would involve a con- 585 tempt. But in the meantime I would like you to state, if you will, whether or not you are the Willard referred to in Aeronautics, at the place indicated, as one of the McCurdy-Willard Aeroplane Company, that is, whether you are the Willard named in the title of that company?

A. I have no answer to make, unless the Court so decides.

XQ102. Will you state whether the business of the McCurdy-Willard Company is to give aeroplane exhibition flights before the public?

Same objections and instructions.

586 A. I will make no answer whatsoever.

XQ103. Will you say whether the McCurdy-Willard Aeroplane Company has heretofore given any such exhibition flights with aeroplanes, of either the Curtiss type or the Curtiss manufacture?

A. No answer.

XQ104. Will you state whether Mr. J. A. D. McCurdy is the McCurdy whose name appears in the title of that company?

By Mr. Newell: Same objections, and these are to be understood to this entire line of improper cross examination. These
587 matters have nothing whatever to do with the case.

By Mr. Toulmin: But these matters have a great deal to do with the credibility of the witness.

By Mr. Newell: The above is the usual excuse interposed by counsel when desiring to go into matters outside of the case. It is believed that the Court will not be led astray by any such statement.

By Mr. Toulmin: And a very proper ground for asking these questions in this case.

588 A. I refuse to answer.

XQ105. Do you know the initials and name of the Mr. McCurdy whose name appears in the title, McCurdy-Willard Aeroplane Company?

A. No answer.

XQ106. Do you know the initials of the Willard whose name there appears?

A. No answer.

XQ107. Will you state when the McCurdy-Willard Aeroplane Company was formed, and whether is be a co-partnership, firm, or corporation?

A. No answer.

XQ108. If in flying a Curtiss aeroplane or a 589
Curtiss type which in its structural sense means the same thing, if you wish to turn from a straightaway course and to turn around, say a post, what would you do with the ailerons and the rear vertical rudder?

A. In turning around a post I would merely turn the steering wheel, which in turn would operate the rudder, causing the machine to follow the course desired, and I would not necessarily use the ailerons at all.

XQ109. Why do you say "would not necessarily?"

A. I mean to state that without any other ele- 590
ments coming into consideration, I would turn the rudder to a sufficient extent to cause the machine to turn around a given post.

XQ110. What other elements do you refer to in your last answer?

A. The wind, the radius of the circle through which I was turning, or the amount of bank which I was desirous of maintaining. Normally it would have been merely necessary to turn the rudder to a sufficient extent to cause the machine to turn through the desired arc.

XQ111. Well, you may consider my question 108
as referring to an exhibition course, say a racing 591
course, with posts or pylons at either end around which you would be required to turn at the speed you would use on such an occasion and which might be called fast flying. Take cross question 108 and apply it to that situation, and then kindly answer it?

A. I would do substantially as I said in answer to XQ108, to merely turn the rudder to a sufficient angle to cause the machine to turn onto the new and desired course. Having obtained the desired position I would turn the rudder to a substantially neutral position.

592 XQ112. If you did what is stated in the last part of your last answer, with the rudder back to neutral position, would the ailerons keep the machine in its curved course?

A. We have not considered that the ailerons would be used at all under the conditions. If the machine had obtained any degree of angularity, it would be necessary, after securing the desired position on the new course, to use the ailerons for the purpose of rectifying this angularity, meaning by angularity that the transverse axis of the machine has lost its parallel relation to the earth in turning. It was not specifically stated whether the
593 circle was to have been considered as of large radius or small, and in answering I merely state what I would do in turning casually about a given point. In such a casual turning the machine such as I am used to, would assume a most limited amount of tilt, and it is doubtful whether or not it would be necessary to use the ailerons at all.

Adjourned for lunch at 1:10 to 2 P. M.

Resumed at 2 P. M.

XQ113. Well then, if in flying a Curtiss aero-
594 plane or one of that type, say on a racing or exhibition course, with posts or pylons at either end of the course around which you would be required to turn, in a curve having what you have called a "small" radius, at the speed you would use on such an occasion, what would you do with the ailerons and the rear vertical rudder in making such a curve?

A. In the first place, the rudder would be turned fully to one side for the purpose of causing the machine to turn. Under such conditions the machine would assume a normal bank or tilt and

maintain this position as long as the rudder was 595
kept in that position, during which same time the machine would be turning. After the turn had been accomplished and the rudder brought to a position which gives straight flight, the ailerons would be used to such an extent as to cause the machine to lose its tilt and again become parallel to the earth's surface. It might be possible that too much bank or tilt had been given the machine in turning and the ailerons would be used to bring the machine to that degree of tilt desired before the turn had been completed and the rudder returned to its normal position. In an extreme case of short
turning, it may be found that the rudder did not 596
give sufficient bank, or have sufficient power, to turn the machine as quickly as desired, in whicn case the ailerons would be used to give the machine a greater tilt in order that the front and rear elevators might be used to assist the rudder and cause the machine to turn more quickly. In this latter case where more than normal tilt was given to the machine for the purpose of using the elevators as a rudder, it would be necessary to restore the rudder to its normal straight-flying position simultaneously with the use of the elevators in the capacity of rudders. This being due, as is
quite evident, to the fact that the machine having 597
obtained an abnormal amount of tilt, the vertical rudder would act in the capacity of elevator, and unless this were brought to a neutral position, it would act in such capacity as elevator and cause the machine to dive towards the ground. In this instance the sole purpose of the ailerons being used would be to bring the elevators front and rear to such an angle with the ground, that their surface would have the effect of rudders, and being of greater dimensions than the rudder, would cause the machine to turn more quickly than the rudder.

598 Having finished the turn, the elevators would be brought to neutral position and the ailerons employed to rectify the tilt and bring the machine to a position normally parallel to the earth's surface.

By "front and rear elevators" I refer to what has been termed in this case as horizontal rudder. In some of the newer machines, this having been divided so that in place of having the entire surface in front, part of the surface has been placed in the rear of the machine for the purpose of equalizing the strain upon the outriggers which hold these horizonal rudders. In this last case it is
599 quite evident that when the machine has assumed a position of extreme tilt, the horizontal rudder has assumed a position which is substantially vertical, and consequently by its use as a rudder, an effect exactly similar to the rudder is obtained with the advantage that it presents a surface giving a great deal more efficiency and turning effect to the machine as a mass than could be obtained from the rudder.

XQ114. But my XQ113 asked you to state what you do under the conditions named with the ailerons and the rear vertical rudder in making such a turn. Please answer as to that matter, or those
600 features of the machine under those conditions?

A. I have endeavored in answering that XQ113 to show exactly the use and reason for the use of both the rudder and ailerons under practically all conditions in turning.

XQ115. But you have drawn into the answer references to what you term the "front and rear elevators," meaning the horizontal rudder. I do not understand that the horizontal rudder is commonly resorted to under the conditions stated in XQ113. Therefore you will see that you have not confined your answer to the particular things inquired about in that question. 601

A. I believe the first part of my answer to that question dealt specifically with one condition which might arise, and I described the operation of the machine from the start of the curve to the finish. It was my endeavor to show in one answer that more than one method might be used in taking a corner sharply, and in order to make myself understood I felt obliged to give the reasons for using the ailerons and to show that through their use the horizontal rudder was brought into such a position that it could be used to assist in turning, in order that there would be no misunderstanding 602 or inference gained that the additional power to turn was obtained by the ailerons, for such is not the case. The additional turning power being entirely due to the use of the horizontal rudder.

XQ116. Will you state whether in accomplishing what is specified in XQ113 the ailerons would be used to bank the machine as one step in the operation?

A. I don't understand your question.

XQ117. What is it that you don't understand?

A. I don't understand what you mean by "what is specified in XQ113." I see nothing specified, but merely something asked, and no reference in 603 that question to banking.

XQ118. I simply asked you in XQ116, and now I ask you again, if the ailerons would be used to bank the machine as one step in the operation of what is asked you, or assumed to be the case, in XQ113. That is all.

A. In answering that question I pointed out in the first case that the rudder would be used in turning, and that the ailerons would be used if necessary, after having accomplished a turn, to rectify the tilted position of the machine. In the

604 second case, as stated, that the ailerons could be used for the purpose of giving additional tilt to the machine, thereby bringing the horizontal rudder into action as a vertical rudder and the turn accomplished through this means.

XQ119. Well then, do you say that the usual operation, under the condition stated in XQ113, is to first turn the rear vertical rudder, or first operate the ailerons to effect a banking of the machine?

A. I have tried to show clearly that in turning the first operation is to use the vertical rudder, the ailerons being accessories to the turn only to the extent of changing the tilt of the machine,
605 either in giving the machine more tilt for the purpose of obtaining a superior turning power obtainable from the use of the horizontal rudder, or for the purpose of rectifying the tilt in the machine.

The witness stated this morning that he had to go to another town for severals days this afternoon and asked to be excused, until he returned. He is therefore excused at this point, by agreement.

By Mr. Toulmin: This consent is given on the condition of course that to make this deposition available, the witness will return
606 and complete it by allowing the cross examination to proceed to the conclusion.

Dayton, Ohio, March 15, 1912.

Present—Counsel as before.

Mr. CHARLES F. WILLARD, a witness heretofore introduced on behalf of defendant, whose cross examination during defendant's testimony was uncompleted, and who is presented at this time by agreement, for the completion of his cross examination and his redirect examination, testifies as follows: 607

Cross examination (continued) by Mr. Toulmin:

XQ120. In answering cross question 87 you stated that you flew the machine in which the rudder wire broke on one occasion, in San Jose, California, and Provo, Utah and other places, besides Toronto, Canada. I hand you a picture published in the June, 1911, number of Aeronautics showing this machine in flight at Provo, Utah. The picture is entitled "Exhibition flying" above the picture and below are the words "Naturally banked in turning—Willard, in Provo, Utah." Please state 608
where the balancing planes or ailerons were located on that machine.

A. Yes, that is my machine. It is evident from the picture that in this particular instance I had the ailerons or balancing planes close to the surfaces. In this particular machine I placed the ailerons in several different positions and had several different sizes which I used for the purpose of experimenting. The explanation under this picture which you mention was printed by the Editor of the magazine and does not necessarily describe the existing position nor do I wish to be held responsible for the comment by the Editor. 609

XQ121. You mean that the ailerons on the machine shown in this picture were attached to the supporting planes at their rear edges and near the lateral extremities of the planes?

A. I am not sure whether they were suspended just below the main surfaces or just above, in this particular instance. It is evident, however, from the picture that they were in close proximity to it. In the event they were below they were attached to the rear beam by some small extension arms and in the event they were above the surface they were

610 attached to the vertical posts, which separate the main planes, by the use of small pivot hinges.

XQ122. Did you fly this same machine shown in the picture also at San Jose, California?

A. I flew this machine at San Jose but again I am not sure where the ailerons were attached, as I was carrying out some experiments with a view of building the machine which you referred to previously as shown in Aeronautics and which I testified was demolished during the experiment.

XQ123. Are you unable to state definitely the location of the balancing planes or ailerons, with relation to the main supporting planes, in this ma-
611 chine when flown at San Jose?

A. I am unable to state specifically the exact point at which the ailerons were hung during the flights at San Jose and Provo, for these flights were made at a period during my experiments.

XQ124. Well the balancing planes or ailerons were not attached to the posts which connect the main planes, either about midway the length of such posts or substantially so, were they? But instead were located near the rear margins of the main plane, if not exactly behind the rear cross beam of the main plane, is this correct?

A. During these flights, and especially the one
612 shown in the picture, it is quite evident that the ailerons were not located even approximately midway between the surfaces but were rather in proximity with the main surfaces.

XQ125. Are you familiar with what is known as the Farman Bi-Plane machine?

A. I am familiar with the Farman machine from a constructive point of view and from seeing them fly a great many times.

XQ126. And the ailerons in the Farman machine were attached to the rear margins of the main

planes, at points near the lateral extremities of the 613
planes?

A. That is right.

XQ127. And the balancing planes or ailerons in the machines which you flew at Provo and San Jose were attached to the machine in substantially the same location with reference to the main planes as was the case in the Farman machine you spoke of. Is that correct?

A. The ailerons were attached, as stated before, in these instances, in close proximity to the main planes but their operation must not be confounded with that of the Farman, for, owing to the manner
in which these ailerons on my machine were con- 614
trolled, the results obtained are quite different from the Farman. The ailerons on the Farman machine are controlled by what might be termed a single wire on each side, and when these ailerons on the Farman machine are operated the ailerons on the low side are so arranged as to give a lifting effect greater than that which exists while flying on a level keel. The ailerons on the opposite or high side of the Farman machine are allowed to find their own position and do not offer any assistance in the way of pushing the high side down. In my machine which you refer to, on the other hand, these ailerons
were connected, the top one to the lower one on each 615
side, by a stick or spreader and the ailerons on the opposite ends of the machine were connected by double wires in such a manner that when the ailerons on one side were depressed the ailerons on the other side were elevated to the same degree from the horizontal, so that in my machine, a lifting effect was obtained on the low side and a depressing effect was obtained on the high side, while, as before stated, in the case of the Farman machine, the lifting effect was obtainable only on the low side.

XQ125. I show you a published picture appear-

616 ing in "Aero" April number, 1911, showing a machine with the ailerons attached to the main supporting planes and with a likeness of yourself sitting in the machine. The name C. F. Willard appears under the picture and the article below states that you made a number of flights at San Jose, Cal., in March. Please state whether you identify this picture as showing your machine and yourself.

A. This picture was taken of me in Los Angeles, California, the day the machine was set up for trial flight.

XQ126. I will ask you to mark the letter A on the aileron which appears on this picture.

617 A. I have so marked the aileron as shown in the picture.

> The picture representing Mr. Willard in flight at Provo is offered in evidence and marked "Complainant's Exhibit—Willard machine at Provo." The picture appearing in "Aero" is offered and marked "Complainant's Exhibit—Willard machine showing Aileron."

XQ127. And when you flew this machine at Ontario, Canada, as stated in answer to XQ87, were the ailerons arranged substantially as shown in
618 "Complainant's Exhibit, Willard Machine Showing Aileron?"

A. The ailerons were substantially in this position while I was flying in Canada and connected as I have described before by a double wire system which moved them simultaneously in opposite directions.

XQ128. You mean that the machine was so organized as to these ailerons on the occasion when the rudder wire broke?

A. Yes, the machine was so organized on the occasion when the wires broke.

XQ129. Did you see the Curtiss flying machines

during the spring of 1911 which were being flown 619
in California at that time?

A. I saw several of them.

XQ130. Did you see the Curtiss machine which Mr. Curtiss had at North Island, near San Diego?

A. You say "the machine." I saw many machines there.

XQ131. How many Curtiss machines did you see on North Island during March, 1911?

A. I am not sure that I was at North Island in March, although I was there sometime in the spring. I can't remember specifically about the the number of machines I saw there during my
visit. 620

XQ132. You mean that during the spring of 1911 and as late as March you visted North Island and saw Curtiss machines there on the island?

A. I cannot state the date I visited North Island more definitely than to say that it was between the first of February and the last of April. At the time of my visit however, I did see the Curtiss machines at North Island.

XQ133. Did you see the cleared away course said to have been about 50 feet wide and something like a mile long in which Mr. Curtiss prepared for operating his machines on the island?

A. I saw several courses cleared away on the 621
island one of them, as a matter of fact, is approximately 50 feet wide and somewhat over a mile in length, straight away.

XQ134. On any of the Curtiss machines which you saw in California, including those on North Island, within the time you have stated, was there any device alleged to be for the purpose of equalizing the head wind pressures on the ailerons at opposite sides of the machine, when the ailerons were adjusted in connection with recovering lateral balance?

622 A. Yes, I saw an equalizing device on these machines and on all others which I have ever seen with the exception possibly, of the first and original Curtiss type machine, and while these devices are applied and are practical in their operation, they are, in a sense, unnecessary as they are not called upon in actual operation of the ailerons because there is no difference in pressure to manipulate them.

XQ135. Then will you state why they have been applied to the Curtiss type machines if your statement that "they are in a sense unnecessary" is correct?

623 A. Personally I never could see the necessity of their presence for in operating the Curtiss machines both with and without this equalizing device I found the machine behaved so far as I could see in precisely the same manner which would show conclusively that there is no turning tendency caused by the ailerons. The only reason that I could see for the equalizers being installed upon the machines might be described as a scientific cure for an imaginary ailment.

XQ136. And was this so-called equalizing device on the machines of the Curtiss make which you have flown as testified in your direct examination?

624 A. This device, which is in fact a practical equalizing device has been on every machine that I have flown with the exception as I have mentioned before of the first Curtiss machine.

XQ137. Does your last answer mean that this so-called equalizing device has been used on the machines which were made under your supervision for yourself and which you have called Curtiss type of machines, including your machine shown in the Exhibit pictures offered in evidence to-day?

A. Yes.

XQ138. If the machines you have flown behaved 625
precisely the same with and without the so-called equalizer, as stated in your answer to XQ135, how are you able to say that it is a practical equalizing device, as you state in answer to XQ136?

A. It is very easy to demonstrate: First, by the every day simple laws of applied mechanics and mathematics that there could be no difference in pressure on the ailerons to which this device is connected by wires, without this device performing the functions for which it was designed.

Second, it is equally simple and as equally convincing to demonstrate the efficiency and practi- 626
cability of this device while the machine is at rest on the ground merely by operating the ailerons by hand and introducing resistances which would correspond to the imaginary unequal resistances in question.

XQ139. Did you meet Captain Paul W. Beck and Lieut. T. G. Ellyson while you were in California in the spring of 1911?

A. I met both of these gentlemen in California either in the late winter or early spring of 1911.

XQ140. Did you meet them on North Island during that time?

A. I did meet them on North Island during that 627
time of my visit there.

XQ141. Did you meet them on North Island during the time Mr. Curtiss was schooling them how to fly Curtiss machines?

A. I believe both of these gentlemen were there at the time I met them for the purpose of receiving instructions from Mr. Curtiss.

XQ142. Did you ever have any conversation with either Capt. Beck or Lieut. Ellyson, with reference to this so-called equalizing device.

A. I positively cannot remember whether or not our conversation touched upon that subject, how-

628 ever, we did talk at least in a general way about aeroplanes during my visit there.

XQ143. Can you say whether either of these gentlemen appeared to know of this alleged equalizing device?

A. Not remembering having spoken about this device with these gentlemen I cannot say, but it would hardly seem possible that men with a practical engineering training, which they have had, would readily overlook the existence of the equalizers. On the other hand the device is of such small dimensions and occupies a position which might cause its being mistaken for a back rest for
629 the shoulder yoke.

XQ144. This device is attached to the back piece of the shoulder yoke in Curtiss machines so that any one riding as a passenger on the machine and sitting directly behind the aviator would have the device within a few inches of their face, would they not?

By Mr. Newell: Objected to as indefinite as to what is meant by a few inches.

A. This device is placed substantially as you say and while it might be considered to be within a few inches of the person's face, yet at the same
630 time I don't believe it would be possible for any one to see its operation insomuch as the working parts are entirely enclosed in a metal case, assuming, of course, that it was required to fill its designed capacity, of an equalizer. The metal case referred to is merely the exterior part of the equalizing device taken as a whole, and is attached to the rear part of the shoulder yoke.

Recess.

XQ145. I wish you would now describe this so-called equalizing device which you testified has been put on all of the Curtiss machines except the very first original machine. 631

By Mr. Newell: Counsel for defendant has heretofore objected to the inclusion of the equalizing device on the ground that such construction was not proved on the *prima facie* case, but only the machine shown in complainant's exhibit "Drawing of Defendant's Machine." Testimony as to this equalizing device was first dragged out in the cross examination of defendant's witnesses, under objection at that time. Such testimony is therefore improper cross examination and is objected to although not specifically made after each question. 632

A. This equalizer consists of a metal case, a pivot running through the case from front to rear and mounted upon this pivot in the case is a small lever, the pivot passing through the center of the said lever mechanically. On either end of this lever are connected wires by means of small metal parts which are so attached to the ends of the lever as to allow for its movement sideways upon its pivot and yet at the same time not resist its action by friction. This constitutes all the working parts of the equalizer. 633

XQ146. And to this lever are connected, through the small metal parts, which I understand, are in the nature of links or loops, the wires or cables which run to and are connected to the ailerons, is that correct?

A. Yes, substantially so.

XQ147. Why did you put this so-called equalizer on the machines which you have built yourself?

A. Probably because I happened to have shoulder yokes with the equalizer already attached and

634 probably for the same reason, and unnecessarily, that they were invented. I don't know that I derived any particular benefit from their presence.

XQ148. Will you state why Mr. Curtiss added these so-called equalizers to the Curtiss machines?

A. I think it would necessary to ask Mr. Curtiss that.

XQ149. Did Mr. Curtiss, in his many conversations with you and your business relations ever mention to you why he deemed it expedient to put the so-called equalizer on the Curtiss machine?

A. As I remember the case, Mr. Curtiss furnished me with a shoulder yoke to which was
635 attached an equalizer with the request that I install it upon my machine without asking him what it was and that I make flights with the machine so equipped and after having made them, asked me if I noticed any difference in the operation of the machine. I advised him that I did not discover any difference in the operation and he said something to the effect that as long as it did not interfere with my flying that I please leave the attachment on the machine. I replied that I would and I did. Naturally I inquired into its intention and operation but, as I have said before, I can't see any particular advantage in the device, insomuch
636 as the fault, which it is capable of remedying, if such a fault existed, never does exist.

XQ150. And what part of the operation of the machine was it that Mr. Curtiss desired you to observe when he spoke of your using this so-called equalizer?

A. As I said before he just requested its use and that I tell him if I noticed any advantage or disadvantage and the result.

XQ151. What result do you allude to?

A. I allude to the result of the flight with the equalizer on the machine.

XQ152. And what report did you make Mr. Curtiss? 637

A. In my answer to XQ149 I state that I advised him that I did not notice any difference in the operation of the machine and that as far as I could see, the result of the flight with the equalizer was identical with any other flight without it.

XQ153. About when did that take place?

A. I can't remember just when this happened, but know that it was at some place in the South, possibly Memphis, Tenn., possibly San Antonio, Texas. Mr. Curtiss, no doubt, could furnish the exact date.

XQ154. And thereafter Mr. Curtiss continued to 638
put this so-called equalizer on the machines and you continued to use it as you have stated, on the machines you personally have built. Is that substantially correct?

A. That is substantially correct.

XQ155. Among the Curtiss machines you saw on North Island were any of them hydro-plane machines?

A. Yes. There were both types of machine there.

XQ156. In the Curtiss machines what device or feature of construction limits the side movements of the shoulder yoke so that when it reaches the
extreme of movement it is stopped? 639

A. In answer to this I would say that the amount a man could bend his spinal column would in most every case cover this movement.

XQ157. With the Curtiss machines you have flown when they have been tilted out of lateral balance is there a tendency of the machine to slide somewhat sidewise and in the direction of the low side?

A. The Curtiss machine or any other machine would slide sideways if tilted to a sufficiently great

640 angle and not restored to its normal horizontal position.

XQ158. Mr. Post testifying as the witness for defendants and in answer to XQ113 says:

"In the practical operation of the Curtiss machine, when the balancing planes are turned, the machine changes its position, and if the left hand balancing plane was at a lifting angle and the right hand plane at a depressing angle, the machine would not fly horizontal, and in this case would bank up on the left hand side, and does bank up on the left hand side, which would cause the machine to proceed out of a straight line toward the right,
641 as in circling a saucer shaped track, and the rear vertical rudder would not be moved to accomplish a turn from the straightaway course."

Is this statement of Mr. Post's true or untrue?

A. If the machine was tilted or banked, as Mr. Post says, so that the left hand side was the high side and the right hand side the low side, and the ailerons which caused the machine to take this position were held in substantially the position in which he placed them in order to accomplish this tilt or bank, then the machine would depart from the straight line of flight and turn towards the right hand or low side of the machine even with
642 the rudder remaining in its normally neutral position. The accomplishment of a turn by this method must not be confounded with the maintaining of lateral balance by the use of the ailerons in which latter case the machine is not held by the ailerons in a banked or tilted position but is, on the contrary, held if possible on an even keel. Where the ailerons are used for lateral balance they are kept in operation for only a short period of time, while I infer that Mr. Post kept his machine in a tilted or banked condition for a considerable time to accomplish this turn.

XQ159. I show you two photographs offered by defendants in evidence, marked "Curtiss Photograph No. 1" and "Curtiss Photograph No. 2." Disregarding the post which is shown stepped near the bow of the boat and having a pair of tilted ailerons, are the machines shown in these photographs, otherwise the usual Curtiss Hydro-plane machines? I also disregard the forward horizontal rudder, which in the photographs has been removed. 643

A. Yes, as far as I can see, these are the regular type of hydroplane with the exceptions which you have mentioned.

Redirect examination by Mr. Newell: 644

RDQ160. What occupation are you engaged in now?

A. At the present moment I am endeavoring to establish a small factory in California wherein I contemplate manufacturing principally an automatic machine which will be used to pack seedless raisins and in different forms of the similar products.

RDQ161. You were asked about the Farman aeroplane, on your cross examination. If I understand you correctly, the Farman machine has two ailerons on each side, and in restoring balance only 645
those ailerons are pulled down which are on the low side of the machine, without moving the other two on the high side. Is that correct?

A. This is correct.

RDQ162. You were asked about the operation of the equalizer and you said that you had used it. If this device is in order would it operate to equalize the resistances, if there were any inequality of resistances exerted by the ailerons?

A. Yes, if this device or equalizer is kept in proper condition and there were any inequalities, 646 such as you state, the equalizer would work both from a theoretical and practical standpoint.

RDQ163. How many manufacturers of aeroplanes do you know of, as you now recall, in the United States, other than the Wright Company, The Burgess Company and the Curtiss Company?

> By Mr. Toulmin: Objected to as an attempt to introduce sur-rebuttal to the testimony by Mr. Barnes yesterday by using this witness under the guise of redirect examination. This is clearly unlawful and improper, no such matter having been gone into in the direct examination of Mr. Willard.
> 647 This objection is made to any further attempt of this kind.

A. There are a great many well-known manufacturers of aeroplanes in this country other than those that you have mentioned. Such as, for instance, The Queen Aeroplane Company of New York, The Moisant Company, Captain Baldwin, Whitteman Brothers, the Walden Company, Richard R. Sinclair, The Hamilton Aero Mfg. Co. The Rex Monoplane Company, The Benoist Air Craft Co., The American Aeroplane Supply House, The King Aeroplane Co., H. S. Dosh, The Heinrich
648 Bros., The International Aeronautic Construction Company, The Wolverine Aeronautic Company, the Aerial Construction Company and probably as many more which have not been brought to my attention at the present moment.

RDQ164. In XQ158 you were asked whether or not the Curtiss machine if tilted would turn, and you answered that if the machine were held in this position without being restored to normal horizontal, it would turn toward the low side. Is this a general rule with the Curtiss and all other aeroplanes?

A. This is a general rule with the Curtiss and 649
some other aeroplanes.

RDQ165. Is this due to any difference of resistance exerted by the ailerons, or is it due to some other cause, and if so please explain what it is due to.

A. This turning of the machine is in nowise due to any difference in resistance exerted by the ailerons, for there is none, but is due to the fact that when the machine is tilted or banked and held in this position the main planes, which are always at an angle to the line of flight, take an angle to the general course of the machine and act
precisely as a rudder would act if the said rudder is 650
turned to one side or the other. For example, if by some arrangement gravity could be resisted without limiting the movement of the machine and the machine could be made to fly tilted up to at 90 degrees from normal, or in other words, so that the main plane stood in a perpendicular position with reference to the earth, then the machine in its motion would traverse a circular path, insomuch as the main surfaces are always set at an angle to the rest of the machine, and it is therefore easy to see that the main surfaces would act precisely as the same amount of surface in the
form of a rudder. The degree to which the machine 651
is tilted from the normal, in almost every machine, will, of course, govern the efficiency of the main surfaces in the capacity of a rudder.

RDQ166. Then, if I understand you correctly, if the machine is tilted up (whether by the use of the ailerons or not) and this tilt is retained, the machine would, even if it did not slide or skid, turn toward the low side?

By Mr. Toulmin: Objected to as leading and stating what is not in Mr. Willard's last answer.

652 A. This is exactly what I mean, that is, if the machine is tilted by any means and the tilt is retained the machine will, of its own accord and necessarily, turn in the direction of the low side.

RDQ167. In banking up the machine the aileron on the side which it is desired to be raised is, of course, turned down and the other one turned up. Have you ever observed whether the machine was turned toward the low side in a case in which the greater angle of incidence was purposely put on the aileron which was turned down in banking and which was therefore on the elevated wing. If so please explain what was done and what happened.

653 A. I have observed a flight in which both ailerons were given a very considerable positive normal angle which, of course, produces the result that when the shoulder yoke was moved, thus operating the ailerons, the aileron which was turned down acquired an enormous and unreasonable angle while the aileron on the opposide side, when moved up simultaneously, was brought into a position of practically a negative angle. In addition to this the steering wheel in the machine had been removed, making any movement of the rudder impossible. Now with the machine in this condition a flight was made. When
654 the machine had attained sufficient altitude, I should say 100 feet or more, the machine was caused to tilt so that the left hand side, the machine proceeding away from me, was the low side and the right hand side necessarily therefore, the high side. To accomplish this tilt it was necessary, under these conditions, that the aileron on the side to be elevated be given a more positive angle, and the aileron on the side to be lowered be given a less positive angle, in fact, in this case by the previous arrangement of the ailerons, as I have specified, the aileron on the low side assumed prac-

tically a neutral angle, while all the effective tilting was done by the aileron on the high side. 655
Now, with the aileron on the side to be elevated offering the greatest possible resistance, more than it could ever offer if the aileron were properly adjusted, and with the aileron on the side to be lowered offering practically no resistance, the machine tilted sharply so that the left hand end, as before stated, was the low end, and the machine, despite the fact that the great resistance was on the high side, turned to the left or low side.

After the turn had been accomplished the position of the ailerons was changed so that the aileron on the low side was given the positive and greatest 656
angle while the aileron on the high side assumed a neutral position.

Now, with the ailerons in this last position, the machine gradually resumed its naturally horizontal position, gradually losing its turning effect as the machine neared the normal level, and when this normal level was reached the machine flew in substantially a straight line. These flights were repeated several times, banking the machine first to the left and then to the right, and in each instance, despite the fact that the aileron on the high side was doing the greatest work, the machine in each and every case turned in the direction of the low 657
side.

RDQ168. Please state how many ailerons there were on this machine and where they were located and pivoted?

A. There were two ailerons on this machine, one on either end, pivoted on and located midway of the front posts on either end of the machine.

RDQ169. Was this a special experiment, with the exaggerated angle of the ailerons purposely made, or was it an accidental happening?

A. These ailerons were purposely set with a pos-

658 itive and exaggerated angle when in a normal position and the flights were purposely made in the nature of experiments.

RDQ170. How long was the flight or flights, in which these things occurred?

A. Each flight was over a mile in length or approximately so.

RDQ171. And did you see the operation you have described above take place only once, or several times?

A. Several flights were made under these conditions and more would have been made, and of longer duration but for the fact that it rained. In
659 each flight the machine was turned and banked two or three times.

RDQ172. What machine was this?

A. This was a genuine Curtiss machine, flown by Mr. Curtiss.

RDQ173. Was there on that machine at the time of those flights any device for equalizing the pressures exerted by the ailerons?

A. No, ailerons were wired direct to the sides of the shoulder yoke, as in the case of the original machine.

RDQ174. If you, yourself, made any flight especially to test the question whether or not the aile-
660 rons on the Curtiss machine would cause the machine to turn, or necessitate the use of the vertical rudder, please describe what the machine was, how its ailerons were arranged, what flights you made, and what happened?

A. The machine used in the tests just previously described was, with reference to its ailerons, etc., an exact duplicate of the original machine, and, I purposely flew this machine over a course of more than a mile, grasping the steering column below the wheel and rocking the machine from side to side, throughout this flight. The machine flew

in a perfectly straight line and landed in the course 661
already described as being substantially over a mile long and 50 feet wide. After landing I turned the machine around and flew back over the same course rocking the machine as in the first flight and landing as in the first flight directly in the course. The machine having maintained its position over the center of the course during the entire flight. The ailerons in this instance were set, as they always are, so that they had practically no angle and in a normal position and parallel. Both of these flights were made without using the rudder after the machine had left the ground and until it reached the
ground at the finish of the flights. 662

RDQ175. This machine which you just referred to had the ailerons pivoted on the front post, and directly connected to the shoulder yoke, that is without any equalizer?

A. Yes, this is the case.

RDQ176. When the Curtiss machine is flying horizontally, please state what happens if the rudder is turned (to the left for example) and without moving the ailerons at all.

A. The machine would turn and continue to turn to the left. The right hand of the machine would become tilted up and the left hand
side down due to the fact that the right hand 663
side of the machine has been made to go faster and the left hand side retarded in its progress.

RDQ177. Assuming that the Curtiss machine loses its lateral equilibrium somewhat, that is, one side dropping down from some cause or other somewhat, what happens if the vertical rudder is then turned toward the elevated side, even though the ailerons are not moved, at all, from their neutral position.

A. In this case the machine would turn toward the high side under the influence of the rudder, 664 and the low side of the machine, due to its increased speed would gradually raise while the high side of the machine would be gradually depressed, due to its loss of speed, and if when the machine had reached its normal lateral balance the rudder was not turned back to its normal straight position the side which had been the low side would eventually become the high side and the side which had been high side would eventually become the low side in continuation of the action just described.

RDQ178. If the tilt is not too great, is equilibrium often restored in this way, that is, by
665 merely turning the rudder to the high side and without using the ailerons?

A. Personally I don't make a practice of this method of regaining equilibrium, although the Voisin machines in some of their models have depended upon this system of steering the machine to maintain their equilibrium. The Newport machine, while it is equipped with other means is, I am told by an operator of one of these machines, very frequently kept in equilibrium by merely using the rudder as above described.

666 RDQ179. The Voisin machine, to which you referred as being kept in equilibrium merely by the use of the rudder, had no ailerons, warping wings or such devices, did it?

A. The model of this machine which I have in mind had no such auxiliary attachments for maintaining equilibrium and depended solely upon the use of the rudder.

RDQ180. Is that Voisin machine a practical flying machine?

A. The Voisin Company is known as a very reputable company and have built many well-

known models. This particular type of machine, 667
however, could not be compared with or handled
as conveniently, especially in small places, as
other makes of machines, yet it seems they made
a great many flights with this type of machine
equipped only with the rudder.

RDQ181. If the vertical rudder of the Curtiss machine is ever used simultaneously with the ailerons in restoring balance, which way is it turned, toward the high side or the low side?

A. If the vertical rudder is ever used simultaneously with the ailerons it is turned towards the high side.

RDQ182. Is the rudder so turned because of 668
any difference of angles or resistances on the
two ailerons?

A. The rudder is not turned because of any
resistance or with any other reference to the
ailerons. It is turned to the high side solely
and distinctly for the purpose of gaining the
additional restoring power of the rudder in
exactly the same way that it is used singularly
in the case of the Voisin machine just previously
described. In other words, when the rudder
is turned to the high side for the purpose of
restoring equilibrium it is acting in the capacity 669
of a separate and distinct restoring member and
has nothing whatsoever to do with the ailerons any
more than that it and the ailerons are both
being used each as a separate agent to accomplish
a desired result more quickly or more
positively than either agent alone has the capacity
of doing. In this case the use of the rudder
might be imagined to take the place of a large
weight which, when it was found that the
ailerons are not sufficiently sensitive would be
slid from the centre of the machine out toward

670 the high side for the purpose of bearing down on that side of the machine, and assisting in restoring the machine to its normal lateral position.

RDQ183. Is there in the Curtiss machine at any time (even though the equalizer is not present) any difference of resistance exerted by the ailerons sufficient to cause the machine to turn about its vertical axis, even though the rudder is not turned?

A. I have never noted any turning tendency in the Curtiss machine due to difference of pressure on the ailerons sufficient to cause the machine to
671 turn about its vertical axis, even though the equalizer were not present.

CHARLES F. WILLARD.

It is hereby agreed between counsel that the certificate of the Notary to Mr. Willard's deposition, as to the part taken to-day, be waived and that counsel for defendant may take the original and send it to the Clerk for filing.

Adjourned at 5:15 P. M., March 15, 1912, subject to further notice.

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672 GEORGE KIBBE TURNER, a witness introduced on behalf of defendants, being duly sworn, deposes and says in answer to questions propounded by Mr. Newell:

Q1. Please state your name, age, residence and occupation?

A. George Kibbe Turner; age, 42; residence Hastings-on-the-Hudson, New York; occupation, Staffwriter and Associate Editor of McClure's Magazine.

Q2. Did you have a conversation with Messrs.

Orville and Wilbur Wright and thereafter write 673
a magazine article in regard to the same?

A. I did.

Q3. Have you that article with you?

A. Yes, here it is.

> The article referred to, in the February 1908 Number of McClure's Magazine, is herewith introduced in evidence, and marked as Defendants' Exhibit "Turner Article."
>
> By Mr. Toulmin: The testimony and exhibit are objected to as incompetent under the circumstances indicated, and because immaterial, since the patent application for the 674
> patent in suit had been filed before the date of the visit of Mr. Turner with the Wrights. This objection is made once for all.

Q4. Does or does not this article give the general results of what you were told by them?

A. It does.

Q5. Did or did not they disclose to you the details of construction and operation of their flying machines?

A. They did not.

Cross examination by Mr. Toulmin:

XQ6. At what date did you visit the Wright 675
brothers prior to writing this article?

A. Sometime during the first two weeks of January, 1907.

XQ7. On the occasion of that visit, did you take any notes on the subject of this article in the presence of either Mr. Wilbur or Mr. Orville Wright?

A. I did not.

XQ8. Prior to that time, had you had any experience in writing on the subject of aeroplane flying machines?

A. I had not.

676 XQ9. Is the language you have employed in this article your own language?

A. It is practically so stated in the article.

XQ10. When you wrote this article you made use of what you saw in newspapers, or other publications, did you not?

A. To the best of my memory, the only publication I made use of were the articles by Mr. Wilbur Wright published by the Journal of the Society of Western Engineers. This answer alludes only to that part of the article which is given as the substance of my conversation with the Messrs. Wright. The introduction to the report of the conversation
677 way of course taken from previous publications of various kinds.

XQ11. You went to the Messrs. Wright as a stranger, did you not?

A. I did.

XQ12. And they received you and treated you with courtesy and chatted with you?

A. Yes.

XQ13. And now you are here to-day testifying to the accuracy of an article you later wrote purporting to state what they stated to you. Is that your position?

A. It is, yes.

678 XQ14. Are you here under subpœna, or voluntarily?

A. I am not here under subpœna, but simply at the request of Mr. Newell.

XQ15. In the case of The Wright Company against Louis Paulhan in the United States Circuit Court for the Southern District of New York, you gave an affidavit embodying what is in this magazine article as to the part that purports to state your interview with the Wrights, did you?

A. I gave an affidavit to Mr. Israel Ludlow which I presume was for that purpose.

XQ16. That affidavit was executed on or about 679
the 31st of January, 1910, here in the City of New York, was it not?

A. I don't remember the date.

XQ17. Please examine the printed copy of your affidavit between pages 243 and 248, inclusive of both, in the record entitled "United States Circuit Court of Appeals for the Second Circuit, The Wright Company, Complainant-Appellee, vs. Louis Paulhan, Defendant-Appellant, Transcript of Record Appeal to the Circuit Court of the United States for the Southern District of New York," and state whether that is the affidavit you gave
for use in the Paulhan case? 680

A. I understand that it is. Mr. Ludlow, who had had some dealings with the magazine concerning articles on aviation, came to me and asked me to state that my article was what it purported to be, an interview with the Wright brothers. He made excerpts from that article, and I made an affidavit to the effect that to the best of my knowledge and belief this was a statement of my interview.

XQ18. In the Court of Appeals record before you at page 248, it is shown that your affidavit in the Paulhan case was dated January 31, 1910,
and marked "Filed February 18, 1910, by John 681
A. Shields, Clerk," is it not?

A. Yes.

XQ19. The copy of the affidavit which you have before you (the portion on pages 244 and 248) does not contain all of the article in McClure's Magazine. Do you mean to say that the affidavit contains all that the Wrights told you, or only portions thereof?

A. Only portions thereof.

GEORGE KIBBE TURNER.

Adjourned to 10.30 A. M. Sept. 26, at 4.15 P. M.

682 New York, N. Y., Sept. 26, 1911,
10.30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

GLENN H. CURTISS, a witness introduced on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence and occupation:

A. Glenn H. Curtiss; age 33; residence, Ham-
683 mondsport, New York; occupation, manufacturer and operator of aeroplanes.

Q2. Are you the Glenn H. Curtiss who is one of the defendants in this case?

A. Yes.

Q3. Will you please state, only roughly of course, how many flights you have made operating your aeroplanes since the beginning of the year 1909, and mention some of your longest flights.

A. I have made several hundred flights, among which were a flight from Albany to New York; from Cleveland to Sandusky, Ohio, and return; a fifty (50) mile flight over the Ocean at Atlantic
684 City, and many flights at Hammondsport, New York, and San Diego, California.

Q4. You also won the International Cup for aeroplanes at Rheims, France, in 1909?

A. Yes, I did.

Q5. I show you here Complainant's Exhibit "Drawing of Defendants' Machine," which has been introduced in this case and which Mr. Hammer, a witness for the complainant, has testified was used by you. Does that drawing correctly show the curve of the main supporting planes?

A. The curve shown in the drawing is not the

same as used on the Curtiss or so-called Herring- 685
Curtiss aeroplane.

Q6. Should the deepest part of the curve have been shown toward the front of the planes?

A. Yes.

Q7. Two ailerons are shown on the drawing pivoted to the front post. They are shown as curved. Is that curve shown correct?

A. The curve in the drawing appears greater than the actual curve on any ailerons used.

Q8. I see that on the drawing no engine or propeller is shown. Were your machines provided with an engine and propeller, and, if so, please
state where it was located, what sort of an engine 686
you used, how many propellers, and where located?

> By Mr. Toulmin: Objected to as calling for immaterial matter outside of the issues raised on the patent claims, as no engine is involved in the case. This objection is made once for all.

A. The drawing was evidently made from an aeroplane as indicated by the braces running to the engine bed. The engine in the machine represented by the drawing was located about midway between the upper and lower surfaces just behind
the aviator and was a Curtiss motor of approxi- 687
mately 25 horsepower, driving a directly connected six foot propeller.

Ett. dwg. from mach.

Q9. This was a gasolene engine?

A. Yes.

Q10. Where was the gasolene tank located?

A. The gasolene tank in this machine was hung from the upper surface of the aeroplane at a point directly above the engine.

Q11. Where was the radiator, if any, located?

A. The radiator was in front of the engine and back of the aviator.

Q12. There is no chassis shown on the drawing.

688 Please state what this chassis consisted of, and where located?

A. The chassis or running gear was what is known as the Curtiss type and consisted of three wheels, two of which are located about six feet apart just beneath the rear edge of the main surfaces of the aeroplane, and a third wheel located about nine feet forward of the rear wheels and between them so as to form a triangle, the front wheel being braced by the diagonal pieces shown in the drawing referred to, besides other vertical and horizontal braces. The rear wheels support the aeroplane by vertical and diagonal tubular braces.

689

By Mr. Toulmin: The objection of immateriality is repeated, once for all, to the subject-matter of answer to Q12.

Q13. Please state what the weight of this machine was, including the aviator?

A. About 650 pounds.

Q14. What was the size of each aileron indicated on the drawing?

A. About two feet deep, and 5 1/2 feet long.

Q15. What was the distance between the two outside front posts?

A. About 26 feet.

690 Q16. What was the width (fore and aft) of the two main planes?

A. The width (fore and aft) or depth of the surfaces, as I term it, was 4 1/2 feet.

Q17. What was the size of each of the two planes of the horizontal rudder shown in front of the machine?

A. Each of the surfaces was approximately two feet by six feet (2′ x 6′).

Q18. How far in front of the front post between the main supporting planes was the rear edge of the horizontal rudder?

A. About eleven feet (11'). 691

Q19. What was the size of the fixed horizontal surface J in the rear of the machine?

A. About two feet deep and six feet wide.

Q20. How far in rear of the main planes was the front edge of this surface?

A. About 10 1/2 feet.

Q21. What was the size of the vertical rudder indicated by I on the drawing?

A. This rudder was three feet high and 25 inches deep.

Adjourned at 11:40 at the request of Mr. Newell, who has a conference set for this time, to meet at 1 P. M. 692

Resumed at 1 P. M.

Q22. You have flown this machine indicated in the drawing (constructed as above described by you) a great many times. Is that correct?

C. flew in mach. like our drg.

A. I have.

Q23. About how fast would this machine fly, driven by its engine?

A. About from 35 to 38 miles an hour.

Q24. In the drawing of defendants' machine, the ailerons appear to be set in the same plane. In that machine what was this normal set with relation to the rush of air toward the machine in flight? Of course I mean before the ailerons were moved. 693

A. The ailerons were set in a position neutral to the line of flight.

Q25. When the operator moved his body to one side or the other to move the shoulder frame, and consequently the ailerons, it would seem from the drawing that the ailerons would be moved on their pivots in opposite directions. Is that correct?

A. That is correct.

694 Q26. In so moving them they would seem to be moved an equal amount from the normal set position. Is that correct?

A. That is also correct.

Q27. Assuming that the machine has a tilt, that is, with one wing higher than the other, and with the vertical rudder in its central position, will the movement of the ailerons bring the machine back to the horizontal without the use of any other element or part?

> By Mr. Toulmin: Objected to as leading; also as indefinite because it is not stated
> 695 whether the machine is in a straight-away course or a curved course at the time referred to in the question.

A. The ailerons are for preserving the lateral balance of the aeroplane, and when properly operated by the aviator will do so under all ordinary conditions, whether the aeroplane is in a straight or curved flight, and without the use of any other element or part.

Ailerons for preserving lateral bal.; do so under all ordinary conditions without use of other part

Q28. Have you ever been instructed to pay particular attention to whether the use of the ailerons in restoring equilibrium caused, or did not cause, any spinning or swerving of the longitudinal axis
696 of the machine, and, if so, please state about when you were first instructed to pay particular attention to this, and who gave you those instructions?

A. I believe that our Patent Attorney, Mr. Newell, instructed me to make special observations and to secure information on this point soon after the claims of infringement by The Wright Company were made known, and while the principle on which the Curtiss machine is balanced and the way in which balance is accomplished is quite different from that used in the Wright machine, and while it is well known to me that there is no swerving of the machine on a vertical axis when

Ailerons do not cause machine to swerve.

the ailerons are operated as they are to sustain 697
lateral balance, still I have made special tests and observations to show this to be a fact.

Ailerons to sustain lateral balance

Q29. Did or did not the use of the ailerons, in any of the Curtiss or Herring-Curtiss machines which you have flown, cause the machine to spin or swerve?

A. In all my flights I have paid particular attention to this matter, and I have never detected any turning effect caused by the operation of the ailerons. I have tried wiring up the ailerons in such a manner as to produce the same result as if the machine were flying out of its normal angle
so as to get a condition which the complainants 698
claim sometimes exists, and even then a straight line flight of indefinite length can easily be made while the ailerons are operated as usual, and there is no necessity or occasion to use the vertical rudder to counteract or prevent any turning effect caused by the use of the ailerons.

Never detected turning effect caused by ailerons

Q30. Is or is not any turning effect caused by the use of the ailerons at any time?

> By Mr. Toulmin: Attention is called to the witness's answer to Q27 where he replied to substantially the same question
> now put, and stated that "under all ordina- 699
> ry conditions" the ailerons would bring the machine back to the horizontal without the use of any other element or part.

A. While it may be possible to show theoretically that under abnormal conditions or in a case where the ailerons were not properly wired up there might be in theory a minute difference in resistance of the ailerons, this would be, should it exist, entirely lost or absorbed by greater forces such as inertia, gyroscopic effect of the whirling propeller, the fixed vertical surfaces, the speed of

Inertia, etc would overcome minute difference in resistance of ailerons

No turning effect caused by use of ailerons at anytime

700 the machine, etc., and there is not in practice any turning effect caused by the use of the ailerons at any time.

Q31. Just what do you mean by "in practice?"

A. By "in practice" I mean in practical flight.

Q32. Is it ever necessary to turn the vertical rudder to prevent the ailerons from causing any spinning or swerving of the machine?

A. It is not necessary to turn the vertical rudder to prevent the ailerons from causing a spinning or swerving. The vertical rudder is used for steering, and there is no connection between the use of the ailerons and vertical rudder.

Vertical rudder used for steering

701 Q33. Supposing that the machine was tilted out of balance and the front horizontal rudder were in such a position that the rush of air strikes the under side of the surfaces at an angle. What would be the effect on the machine with relation to its course, even though the ailerons were not moved at all but left in their normal position?

A. Such a condition would probably cause the machine to turn and circle if the condition should be allowed to exist for a sufficient length of time.

Q34. Then the machine may be steered by tilting it and using the front horizontal rudder. Is that correct?

702 A. It is possible to turn the machine when at an angle by the use of the front horizontal rudder, and if the machine were balanced to fly normally with the front horizontal rudder set at a lifting angle, it would not be necessary to move it still further to cause the machine to turn, if the machine were held at an angle, as described in the question: It is this angle at which the front horizontal rudder may be set, however, which would cause the machine to turn.

Q35. Assuming that the machine is flying straightaway and in equilibrium, what would happen if the vertical rudder were turned toward the right, for example, but without using the ailerons? 703

A. Turning the rudder to the right would cause the machine as a whole to start turning in a circle toward the right.

Q36. The machine would also tend to skid off toward the outside of the curve, would it not?

> The Court will note the leading character of the questions, in which the question states the supposed operation, instead of leaving the witness to do that.
>
> Question withdrawn.

Q37. What else, if anything, would occur?

A. Just what else a machine would do under 704
these conditions depends somewhat upon the balance of the machine and the position of the weight carried. I am inclined to think that the machine in the question would assume a slight angle from the horizontal with the outside end of the machine the higher, due partly to the increased speed of the outside wing and the decreased speed of the inside wing, and partly to the fact that the major portion of the vertical surface exposed to side resistance in the machine in question was above the center of gravity of the machine.

Q38. You have said that the use of the ailerons
did not cause any turning or swerving of the ma- 705
chine. Does or does it not make any difference in this respect whether the machine is flying horizontally, up, down, or with a greater or less weight carried, or faster or slower, so far as you have been able to detect?

A. Whether the machine is flying up grade or down grade, makes no material difference, as the rush of air is always contrary to the line of flight, and as I have already mentioned, I made experiments with the ailerons purposely wired up at an angle not the same as the line of flight, to give me

706 a continuous condition such as the complainants' claim might occasionally exist, and I repeat that even then the operation of the ailerons to balance the machine caused no turning or swerving of the machine. Wiring the ailerons so that when they are parallel with each other they are both a little below the normal line of flight, is equivalent to adding weight to the machine or flying it slowly at a great angle of incidence, and wiring the ailerons in a position a little above the normal line of flight is equivalent to the conditions existing when a light load is carried or the machine flying at its fastest speed. I have tried the machine with the ailerons
707 in both positions I referred to, and even under these exaggerated and abnormal conditions a movement of the ailerons sufficient to balance the machine in flight causes absolutely no turning or swerving. The above experiments were made in addition to experiments with the ailerons set at a neutral angle and the load varied, and to my mind do show positively and conclusively that there is no turning effect caused by the ailerons in actual flight.

By Mr. Toulmin: Objection is here made once for all to the testimony relating to alleged *ex parte* tests.

708

Q39. In your last answer you used the expression "makes no material difference." Did you mean to imply that it made any difference at all in the effect caused by the ailerons?

Objected to as leading and stating the conclusion desired.

A. I meant, and should have said, that it made no difference as far as the question under discussion, that is, possible difference of resistance, in the ailerons is concerned.

Q40. Could you or could you not detect, under 709
any of those conditions, any difference in the effect which the ailerons produce?

A. Under none of the conditions referred to was any effect produced other than to balance the machine laterally and keep it on an even keel, or substantially an even keel, and it was not then, and never has been in my experience in flying at any time, or under any conditions, either necessary or desirable to turn the vertical rudder to prevent counteract or resist any turning effect due to the use of the ailerons. The length of time which the ailerons are used to regain balance is not sufficient
to cause a turning of the machine even when the 710
ailerons are purposely affixed to cause a greater resistance on one than on the other, which condition does not actually exist when the ailerons are properly wired for regular flying.

Q41. When did you make the experiment which you have mentioned as "when the ailerons are purposely affixed to cause a greater resistance on one than on the other," and who was present during those experiments?

A. I made a series of such experiments at Hammondsport, New York, several weeks ago, I think in August, 1911. Dr. A. F. Zahm and Augustus
Post were present. 711

Q42. Please explain what you did in wiring up the ailerons above and also below their normal position of set, in those experiments?

A. In making these tests the ailerons were first placed in a neutral position and several flights made. The wire connecting the top of one aileron with the top of the other was then lengthened, allowing them both to droop to an angle of five degrees from the horizontal. The slack in the wires running to the lower side of the ailerons was then taken up and the flights made. In the next trials

712 the wire connecting the tops of the ailerons was shortened and the lower wires lengthened out accordingly until the ailerons were in a position five degrees above the horizontal and ten degrees above their position during the previous experiment. Ten degrees variation is a greater variation than it is possible for the machine to attain so far as the rush of air against the ailerons is concerned in actual flight.

Q43. Did you regain balance in each of those three tests by the use of the ailerons, and, if so, was or was not there any spinning or swerving of the machine?

713 A. In all of the flights it was necessary to use the ailerons to balance the machine, and in at least one instance I purposely operated the ailerons to a greater angle than it is ever necessary to use them, in order to observe, if there was even then, any turning effect, but as I have stated, there was no turning or swerving of the machine about its vertical axis, for the machine continued in a straight course and the vertical rudder was not used at any time. This unusual movement of the ailerons was during one of the flights in which the ailerons were set at an angle to the line of flight.

Q44. Was this machine so used substantially the
714 machine shown in Complainant's Exhibit "Drawing of Defendants' Machine?"

A. It was substantially the same as the machine from which this drawing was made and a duplicate of the machine built by me and flown at Morris Park, New York City.

Q45. Did that machine have on it ailerons which were curved and pivoted to the front post?

A. The ailerons used in the tests were the same as the one referred to by the complainants as curved surfaces. The ribs used in these ailerons deviated about one-half an inch from the straight

line in their total length of 24 or 25 inches. The 715
ailerons were attached to the front posts at either
end of the main surfaces, as shown in Complain-
ant's Exhibit "Drawing of Defendants' Machine."

Q46. Did you on or about February 10, 1910, make any experiments with Augustus Post at Hammondsport, New York, to determine any questions in this case, and, if so, please explain what they were?

A. I made some experiments with an aeroplane
on or about February 10, 1910, at which Augustus
Post was present. These experiments consisted of
a number of flights over a straight course with the
steering wheel which operates the rear vertical 716
rudder tied and sealed in a fixed position. The
flights were made both with the fuel tank full and
nearly empty, and the ailerons were operated in the
usual manner to balance the aeroplane during all
of the fights, and on one or more occasions I re-
call operating the ailerons purposely to an un-
usual degree. In all of these flights the machine
flew in a straight line so far as any turning effect
from the operation of the ailerons was concerned,
and in each instance landed without breaking the
seal of the rudder. I observed particularly that
there was no swerving.

Q47. I show you here three photographs entitled 717
as Defendants' Exhibits "Post Photographs Nos.
1, 2 and 3." If you recognize them, please state
what they are and when they were taken, and
who the person is who appears on the protographs
(Photograph No. 3 showing only the lower por-
tion of the body of a person)?

A. I recognize the photographs as those taken at Hammondsport at the time of the last-mentioned experiments, the person appearing in all the photographs is myself. Photograph No. 1 shows the complete machine as used in the experiment. No. 2 shows the manner in which the

718 steering wheel, which operates the rear vertical rudder, was tied in a fixed position and sealed by pasting a piece of paper over the rim of the wheel and on the post to which the wheel is attached, in such a manner that it could not be moved in the slightest without breaking the seal; and No. 3 shows a stone lashed to the diagonal braces near the front wheel and carried in this manner during one of the flights for the purpose of changing the fore-and-aft balance of the machine. This, however, made no difference in the results. The rudder was not used and the machine did not swerve or turn.

719 Q48. Was that flight with the stone tied on the machine made over the land or over the ice, and about how far was that flight?

A. I think that flight was made over the ice, for a distance of perhaps half a mile.

Adjourned at 4:25 P. M., to Sept. 27, at 10:30 A. M.

New York, N. Y., Sept. 27, 1911,
10:30 A. M.

Met pursuant to adjournment.

720 Present—Counsel as before.

Q49. If you in March, 1911, made any flights over a straight course to test whether the use of the ailerons produces any turning or swerving of the machine, please explain where they were made and what, if any, preparations of the ground had been made for such flights?

By Mr. Toulmin: Objection to these *ex parte* matters and the testimony concerning them is repeated once for all to what is inquired about in the question.

A. I made some experiments at San Diego, 721
California, in March, 1911, assisted by Captain
Paul Beck, and Lieutenant T. G. Ellyson, for the
purpose you mention. Our flying grounds were
located on what is known as North Island, which
forms a large flat peninsula between San Diego
Harbor and the Pacific Ocean. The island is
covered with a growth of weeds and sagebrush,
and we had cleared and rolled a straight course
fifty feet wide and a mile long, running approximately
North and South, to be used for starting
and landing. This narrow strip proved an excellent
course to fly over and enabled the aviator
or passenger, or an observer on the ground, to 722
see plainly whether or not there was any swerving
or turning of the machine in flight. I prepared
for the experiments by seeing that each of the
ailerons on the machine were connected rigidly
to the shoulder control so that when they were
parallel to each other they were approximately
neutral to the line of flight. This aeroplane was
of approximately the same proportions as the
drawing called Complainants' Exhibit "Drawing
of Defendants' Machine." The surfaces were the
same size, and the ailerons were attached to
the vertical posts midway between the surfaces
at either end of the main planes, and were 723
wired up in such a way that if one aileron
were moved either up or down, the other aileron
was bound to move an equal distance in the
opposite direction. I first flew the machine alone,
and then with Lieutenant Ellyson, and later
with Captain Beck as a passenger. The object
of these tests were to determine whether or not
the use of the ailerons produced any turning or
swerving effect, and whether or not the vertical
rudder is used for the purpose of counteracting
any such turning or swerving if it existed.

724 Q50. Are Captain Beck and Lieutenant Ellyson the Navy and Army Officers who have already testified in this case?

A. They are.

Q51. Who made the first flights, that is, did you make them alone, or with a passenger?

A. I made the first flight alone.

Q52. How long was this flight after you had gotten the machine straightened out following the course?

A. This flight was at least half a mile.

Q53. During this time did you, or did you not, use the ailerons?

725 A. The ailerons were used, as usual.

Q54. Could either aileron be moved without moving the shoulder frame?

A. It could not.

Q55. Did you make only one flight alone, or did you fly up the course and then back again?

A. I do not remember whether or not I landed at the end of the course. I may have made a turn over an open field, as we sometimes did in practice flying, and returned to the starting point over the straight course.

Q56. At any rate, you flew up and back. Is that correct?

726 A. That is correct.

Q57. Did the machine follow the course or not, and was or was not there any swerving of the machine when the ailerons were used?

A. As the purpose of the flight was to determine this point, I headed the machine straight along the course so that I myself, as well as those on the ground, could plainly see whether or not there was any swerving of the machine. After the aeroplane was properly headed so that the line of flight was directly over the course, I did not operate my

vertical rear rudder, but did operate the ailerons 727
as needed to sustain balance, and the machine continued in a straight line over the course and without any turning or swerving.

Q58. You have said that you then took up Lieutenant Ellyson. Was any change made in the machine between the flights which you made and the flights in which Lieutenant Ellyson was carried, or in those in which Captain Beck was carried?

A. No change was made in the machine at any time during the experiments. If the added weight of a passenger had caused the machine to fly at a different angle of incidence and thus create a
difference in resistance between the ailerons when 728
they were used, which would cause the machine to turn or swerve, or require the use of the vertical rear rudder to prevent the machine from turning, such a result could have easily been detected by both myself and the passenger, who was purposely seated directly behind me and in plain view of the steering wheel which operated the rear rudder and the straight narrow course over which we were flying. The passenger could also readily observe that the ailerons were operated without taking his eyes from the steering wheel and the course beyond, as in operating the ailerons I necessarily move from
side to side directly in front of him and with my 729
head only a few inches below his direct line of vision. He could also tell that the machine tilted laterally by his own sense of equilibrium, even though he had not seen me move the ailerons. This also applies to the other passenger carried.

Q59. In your last answer, did you or did you not mean to imply that any difference or resistance between the ailerons when they were used would cause the machine to turn or swerve, or require the use of the vertical rudder?

A. From my long experience in building, operat-

730 ing and observing these aeroplanes in flight I know positively that the rear vertical rudder is never operated to counteract or resist any turning effect caused by the use of the ailerons, and I have never been able to detect any tendency to turn or swerve when the ailerons are operated, and I say that in actual practice there is no turning or swerving due to the operation of the alierons. Experiments were made because certain theories had been advanced by the complainants, and I wanted disinterested parties to observe just what actually occurred in flight, and I purposely created conditions most favorable to the complainants' argument, that
731 is, carrying a passenger in a machine on which the ailerons had been wired up in a position neutral to the ordinary line of flight, and flew this machine over a straight and narrow course for a long distance, which was not necessary in ordinary flying. Several of these flights were made without operating the rudder at all for a long distance, and although the ailerons were operated in the usual manner, the machine did not deviate from a straight course.

Q60. I don't think you quite caught the meaning of my question. In the second sentence of your answer to Q58 you said—

732

> "If the added weight of a passenger had caused the machine to fly at a different angle of incidence and thus create a difference in resistance between the ailerons when they were used which would cause the machine to turn or swerve * * *"

This expression is a little ambiguous for it does not clearly appear whether or not you meant to imply that, assuming that there was actually such a difference of resistance on the ailerons, the machine would necessarily swerve or require the use

of the vertical rudder. I merely want that ex- 733
pression quoted cleared up so as to show just what
you meant. Will you please read over Q59 again
and explain what you did mean?

By Mr. Toulmin: In my opinion there is no ambiguity or uncertainty in the matter quoted from the answer to Q58. I also feel that Q's 59 and 60 are directed to have the witness qualify, under the form of explanation, what he has stated in answering Q58. The Court is asked to note this suggestion.

By Mr. Newell: The answer in my opin-
ion is obviously ambiguous for the reason 734
stated above by me, and I think that any impartial person will see that it was so from reading Mr. Curtiss's testimony. I want the record to show what Mr. Curtiss meant, without any question. I don't want any "qualification," but merely an explanation of what I consider is clear ambiguity.

A. In my answer to Q58 there is or should be no
comma after the word "used" in the fifth line of the
quotation. But I can see where my meaning might
be misconstrued, if read alone, but in view of my
previous statement that there is no turning effect 735
no matter what theory is advanced that a
possible slight difference of resistance in the
ailerons would cause a turning effect, my meaning should be understood correctly. You will note that I said "*If* the added weight of a passenger had caused * * * the result could easily have been detected by both myself and the passenger." I do not know that there was a difference in resistance between the ailerons, although the conditions existed which the complainants claim would cause such a difference,

736 but the fact remains that no swerving or turning took place, and it is not difficult to understand that even if there was a slight difference in the resistance on the ailerons when operated due to the abnormal conditions created, there would be no turning or swerving of the machine, on account of the speed of the machine through the air, the vertical surfaces of the struts, braces and other parts which go to make up the machine, the torque and gyroscopic action of the propeller, and other forces and conditions which exist in actual flight.

Adjourned at 1 P. M. for lunch, to 2 P. M.

737

Resumed at 2 P. M.

Q61. During lunch time I explained to you the ambiguity in the second sentence of your answer to Q58. Did you, or did you not, mean to imply that any difference in the angle of incidence on the ailerons when they were used would cause the machine to turn or swerve or require the use of the vertical rudder?

> By Mr. Toulmin: My statement last above made is repeated, and the attention of the
> 738 Court is respectfully invited to this matter.

A. I did not mean to imply that any difference in the angle of incidence on the ailerons when they were used would cause the machine to turn or swerve. I thought that I made this plain in my answer.

Q62. You have not answered in regard to "require the use of the vertical rudder." How about that?

A. If the machine did not turn or swerve, it would of course not be necessary to use the vertical

rudder, and to make it unnecessary for you to ask 739
this question again I will say I did not mean to imply that any difference in the angle of incidence on the ailerons when they were used, would cause the machine to turn or swerve or require the use of the vertical rudder.

Q63. In cases where *theoretically* there ought to be a difference of resistance on the two ailerons when used, does or does not the machine swerve or turn? I mean, of course, in actual flight.

A. The machine does not swerve or turn in actual flight under the conditions you mention.

Q64. In your answer to Q59 you spoke of "carrying a passenger in a machine on which the aile- 740
rons had been wired up in a position neutral to the ordinary line of flight." What did you mean by "position neutral to the ordinary line ot flight?"

A. I meant a position neutral to the line in which the machine is ordinarily flown, that is, when a passenger is not carried. The machine in question was not a passenger-carrying machine and it was necessary to arrange a temporary seat for the passenger in these experiments.

Q65. You have said in answer to Q58 that "no change was made in the machine at any time during these experiments." Did you fly (when you 741
were carrying Lieutenant Ellyson or Captain Beck) at any greater speed than you did when you were flying alone?

A. When I carried a passenger the machine flew at slightly less speed than when I flew alone.

Q66. Did you or did you not use your ailerons in both of the flights which you made with Lieutenant Ellyson and with Captain Beck?

A. I did use the ailerons in all of the flights.

Q67. Please state whether or not there was any

742 turning or swerving of the machine in those flights when the ailerons were used?

A. There was not any turning or swerving of the machine in those flights when the ailerons were used, as I have stated before.

Q68. Did you operate the rear vertical rudder?

A. I did not operate the rear vertical rudder at any time to counteract any turning effect caused by the use of the ailerons, and on several flights did not move the rudder at all after the machine was in the air and headed along the course.

Q69. When you made your flights alone there
743 was, of course, some angle of incidence on the main supporting surfaces of the machine. You have said in answer to Q58 that no change was made in the machine at any time during the experiments. You have also said in answer to Q65 that when you carried a passenger the machine flew at slightly less speed than when you flew alone.

What change, if any, occurred in the angle of incidence on the main supporting surfaces due to the carrying of a passenger?

A. Adding the weight of a passenger would of course, under these conditions, make the machine fly at a slightly greater angle of incidence.

744 Q70. As the set of the ailerons was not changed, what effect would this have on the angle of incidence on the two ailerons when they were used?

A. As the ailerons were not quite neutral to the line of flight when a passenger was carried, the ailerons when operated would assume slightly different angles to the existing line of flight.

Q71. I show you here three photographs and ask you whether you recognize them, and, if so, please state what they are?

A. I recognize the photographs as having been taken at our Training and Experimental Grounds

at Hammondsport, New York. Two of the pic- 745
tures show Dr. Zahm and myself seated in a hydro-
aeroplane on which a device for experiments is lo-
cated. The third picture shows the device removed
from the aeroplane and photographed on the
ground.

> The three photographs referred to are introduced herewith in evidence and requested to be marked as Defendants' Exhibits "Curtiss Photograph #1," "Curtiss Photograph #2" and "Curtiss Photograph #3."

Q72. The machine so shown in Photographs #1
and #2 is one of your hydro-aeroplanes in which 746
you rise from and alight on the water, except that
the front horizontal surface or "horizontal rudder"
has been removed and the device shown in Photo-
graph #3 substituted. Is that correct?

A. That is correct.

Q73. When were these experiments with this machine and apparatus made?

A. On or about August 10, 1911.

Q74. 1 indicates a boat which is long and narrow
and which supports the machine on the water and
is curved upwardly underneath at its front end,
and 2 indicates a float, one at each end, which,
when the machine is running over the water, pre- 747
vents either side of the machine from tilting down
into the water. When the machine is running at
full speed through the water, the lift of the air
on the main supporting surfaces and the inclined
front under-surface of the boat causes the boat to
be inclined upwardly and to almost rise out of the
water, only touching the water toward the stern.
Is that corect?

A. That is correct.

748 Q75. Referring now to Photograph #3, which shows the apparatus detached from the machine, please explain what it is and who built it?

A. The apparatus was built under the direction of Mr. Newell and Dr. Zahm at our shops in Hammondsport, N. Y., and consists of two complete ailerons which were once used on a Herring-Curtiss aeroplane and are the same as described in complainants' drawing, being about two feet deep and six feet wide, having a slight curve from front to rear. These ailerons are attached by their front edge to a three-quarter inch steel tube, which tube is fixed in a horizontal position and guyed by wires
749 to a vertical post at its center and half way between the two ailerons which are about a foot apart. The vertical post is pivoted at its top and bottom so that the ailerons are free to rotate about this vertical axis. As shown in the photograph the ailerons are set one at a negative and the other at a positive angle.

Q76. Were these ailerons free to rotate about the horizontal steel tube, or were they fixed with relation to each other.

A. They were fixed at equal angles above and below the steel tube by guy wires running from their edge to the top and bottom of the vertical
750 post in the center between them.

Q77. What was the part which I indicate by the numeral 3 on the photographs?

A. This was an oblong piece of wood about half an inch thick and attached to the vertical post in the manner of a hinge and in such a way that it would act as a vane. On this vane a silk thread was attached and a scale in the form of a pro tractor marked on the wood so as to indicate the angle at which the silk thread drifted in the air relative to the vertical post.

Q78. At about what speed does this machine move in contact with the water when carrying two persons?

A. During the experiments the machine was operated at a speed of about 35 miles an hour. 751

Q79. Does Photograph #2 show the machine moving at this speed or at a much slower speed?

A. Photograph #2 shows the machine moving at a slow speed and just coming into shore after an experiment has been made.

Q80. The short cross-piece, indicated by 4 on Photograph #3 is shown, and can be seen on Photograph #1 by closer examination. Please state what this was for, and what was attached to it?

A. The stick was used for the purpose of attaching a pair of scales.

Q81. Was there more than one pair of scales, if you recollect? 752

A. There were two scales.

Q82. What was the part which I indicate by the numeral 5 on Photograph 1?

A. This was a Warner Anomometer for indicating the speed of the wind or the speed of the machine through the air.

Q83. Who took these pictures, if you know?

A. I believe the pictures were made by Mr. Newell.

> It is stipulated that if Mr. Newell were called as a witness he would testify that he took these pictures at the time stated. 753

Q84. Was there any provision by which the foot of the vertical post (numbered 6) could be adjusted either forward or backward, and, if so, please state how this was accomplished?

A. The lower end of the vertical post to which the ailerons were attached was fitted with a small steel pin which rested in a small ~~pole~~ hole in a block of wood on the boat. This block of wood contained a row of holes running fore and aft so that the lower end of the vertical post could be moved from one hole to another forward or backward, thereby

754 adjusting the angle of incidence of the ailerons which were attached rigidly to the post.

Q85. Did you take out Dr. Zahm on some of the trips, and who else, if any one, also took him out?

A. I operated the machine while Dr. Zahm acted as observer and made notes on several trips, and Lieutenant Ellyson operated the machine for Dr. Zahm to make observations on one or more trials.

Q86. Lieutenant Ellyson was then at Hammondsport, N. Y., flying the regular Navy hydroaeroplane?

A. Lieutenant Ellyson was then at Hammondsport practicing flying in the hydro-aeroplane.

755 Q87. These runs were made over the water, were they not, that is, with this device of the photographs?

A. Yes, the aeroplane was never allowed to entirely leave the water.

Q88. I show you here two more photographs and ask you if you recognize them?

A. Yes.

The photographs are introduced in evidence, and requested to be marked as Defendants' Exhibits "Curtiss Photograph No. 4" and "Curtiss Photograph No. 5."

756 Q89. Who is the person seated in the machine in both photographs?

A. Myself.

Q90. I notice that your ordinary ailerons are not shown on this machine. Please state what the two ailerons (which I indicate by 1 and 2) are and how they were operated?

A. The two ailerons shown in the picture were constructed after design shown in what is known as the Boulton British patent. These ailerons are each rigidly attached to a spindle (one for each aileron) which project out at either end of the upper main surface of the aeroplane and which are

attached to the front beam by cleats so that they 757
may rotate. Between the main surface of the aeroplane and the aileron is a large pulley marked 3 on the photograph, around which a steel cable is wound. This cable passes around pulleys across the aeroplane to the other aileron, being wound around the second pulley in the opposite direction, so that when the shoulder control to which the wire is also attached is moved to either side, one pulley and its aileron is rotated in one direction and the other pulley (and the aileron to which it is attached) is rotated in the opposite direction. The controlling wire or cable which is attached to the shoulder
control, after passing over the large pulley on the 758
one aileron, passes through a small pulley at the lower plane, then across to the opposite end of the aeroplane, then up around the large pulley on the second aileron in the opposite direction, then down and around a small pulley at the lower surface, and back to the shoulder control. The surfaces on each aileron, are 18 inches deep, that is from front to rear, and four feet and ten inches wide. The pulleys are 12 inches in diameter.

By Mr. Toulmin: Objected to as incompetent for any purpose.

Q91. I show you here a copy of the drawings of 759
the Boulton British patent No. 392 of 1868, and ask you whether or not the way the cable was wound on the machine you have just described caused the ailerons to move in precisely the same manner as shown in Figs. 5, 6 and 7 of the Boulton drawing, assuming that the portion lettered *d* on Fig. 5 represents the shoulder control on the machine of the photographs?

Objected to as leading and assuming an analogy between the rolling weight *d* of the

760 Boulton patent and the shoulder yoke referred to in the question.

A. The cable was attached to the ailerons in the experiment in the same manner as shown in the drawing referred to and would operate the ailerons in precisely the same manner and the shoulder control was attached at a point equivalent to letter *d* in Fig. 5.

Q92. Did you make any flights with this machine so rigged up?

> By Mr. Toulmin: The last and any other question and answer concerning the alleged
> 761 machine shown in the photograph are objected to once for all as incompetent matter involving afterthoughts based upon the teachings of the Wright patent.

A. Yes, I have made several.

Q93. Did you make any flights other than straight-away flights, and if so, please state what you did?

A. Besides the straight-away flights, I made several semi-circular flights, and at least one complete circle returning to and landing at the starting point, which was a difficult flight to accomplish
762 over the limited grounds where the experiments were made.

Adjourned at 4.30 P. M. to Sept. 28, at 11 A. M.

New York, N. Y., Sept. 28, 1911.
11 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

Q94. If any one was present during flights made by you with this arrangement of ailerons shown in

Curtiss Photographs No. 3 and No. 4 in August, 763
1911, please name him.

A. Mr. Emerson R. Newell, was present during the flights mentioned.

Q95. Was Dr. Zahm present at any flights with this construction of ailerons, and if so, when?

A. Dr. Zahm was present at Hammondsport, N. Y., in August, 1911 while I made flights with this device.

Q96. During those flights did you use the ailerons to restore balance of the machine and, if so, did you do this more than once?

A. Yes, I used the ailerons many times during
the flights. There was some wind blowing and on 764
account of the uneven ground, the machine usually left the ground with the main planes at an angle requiring the use of the ailerons to bring them back to horizontal position.

Q97. Were or were not these Boulton ailerons successful in operation in these practical flights?

> Objected to as calling for conclusion without stating the facts which would show the result.
>
> By Mr. Newell: Such facts have already been shown.

A. The Boulton ailerons proved very efficient 765
and were thoroughly practicable.

Q98. Did you have any trouble landing the machine in those flights?

A. I had no trouble whatever.

Q99. In the runs with the hydro-machine shown in the Curtiss Photographs Nos. 1, 2, and 3, you have spoken about a fine silk thread on the wind vane. You have also stated that the machine ran 35 or more miles an hour over the water. At that speed did the thread "whip" in the rush of air or stand out straight?

A. A fine silk thread of six or eight inches

766 will not flutter in the wind of 35 miles an hour, and on this occasion the thread was approximately straight and still in the rush of air.

Q. 100. Have you noticed in your machines whether or not moving the ailerons back and pivoting them to the rear posts instead of to the front posts, produces any change of effect when the ailerons are used and, if so, please state in a general way what such changed result you have noticed?

A. I have noticed that when the ailerons are attached to the rear posts, they produce less
767 head resistance when operated.

Q101. Do you mean less head resistance on the ailerons themselves, or that the head resistance of the machine as a whole seems to be somewhat less?

A. I mean that the head resistance of the machine as a whole is somewhat less when the ailerons are attached to the rear posts than when they are attached to the front posts.

Q102. Did you ever make a flight with the ailerons attached to the front posts and with the vertical rudder wires disconnected, and, if so,
768 please state who was present?

A. I made such a flight in the Winter of 1910 at Hammondsport, N. Y., in the presence of Augustus Post.

Q103. Was this flight or flights made over the land or over the ice?

A. The flight or flights were over the ice. I do not recall now if I made more than one flight or not.

Q104. In such flight or flights did you, or did you not, use the ailerons to restore equilibrium of the machine?

A. I used the ailerons to balance the machine 769
in this flight.

Q105. Did or did not the machine swerve?

A. The machine did not swerve during this flight, but flew in a straight line as far as it was possible to go without running into the hill which rose from the shore of the lake.

Q106. About how long was this flight?

A. About a third of a mile.

Q107. Was the rear rudder on the machine or not?

A. The rear rudder was on the machine, but the wires which ran through it were disconnected
at the rudder allowing it to drift with the wind 770
or rush of air.

Q108. In the testimony of complainants in this case Mr. A. R. Knabenshue testified regarding a conversation which he had with you in November, 1909, at the Latonia Racetrack in Kentucky, as follows:

> "Mr. Curtiss replied to me that he didn't dare take the chance of flying around the circular course on account of the tendency of the machine to bank to an excessive degree, and he was afraid on ac-
> count of the condition of the infield to 771
> attempt to make the turn, and in order to bring the machine to a level keel he had to turn the rudder to the high side,"

Did you or did you not state to Mr. Knabenshue that in order to bring the machine to a level keel you had to turn the rudder to the high side?

A. Mr. Knabenshue has misquoted me. I did not state that there was a tendency of the machine to bank to an excessive degree, and

772 I did not state that in order to bring the machine to a level keel I had to turn the rudder to the high side.

Q109. Mr. Knabenshue also, in answer to a very leading question by complainants' counsel, in Q6 stated that you on several occasions had told him that while in flight you actually turned the rear vertical rudder toward the high side. Did Mr. Knabenshue state the facts or not?

A. I had no conversation with Mr. Knabenshue regarding flights other than at the Latonia Race-track. Therefore, I did not on several occasions tell him anything that occurred in flights, and
773 I do not recall even on this occasion making any remarks or statements to Mr. Knabenshue other than that I did not think the grounds at Latonia warranted my making circular flights, because if the motor stopped on a turn it would be impracticable to land the machine while it was turning and the grounds outside of the track gave no opportunity to land there.

Q110. In your foregoing testimony you have described several experiments or experimental flights, and in regard to some of them I have asked you whether or not either of the ailerons could be moved without moving the shoulder
774 frame, and you said that it could not. I don't know whether I have asked you specifically in regard to each one of those machines used.

Were or were not the ailerons, in all those machines used in those flights, connected from one aileron to the other and from the ailerons to the shoulder frame, so that neither aileron could be moved without moving the shoulder frame?

A. In all of the trials and experiments to which I have referred have been made with machines on which the ailerons were rigidly attached by cables to each other and to the shoulder frame in such a manner that when the shoulder frame was moved, each aileron was moved an equal amount, one in one direction and the other in the opposite direction up and down, and neither aileron could be moved without moving the shoulder control and the other aileron. By moving the aileron I mean raising or lowering the rear edge, the front edge being attached to the vertical posts and guy wires on the machine. 775

Q111. In all those experiments, if the movement of the ailerons produced by moving the shoulder frame, or the movement of the ailerons, was any different from that indicated by the shoulder frame and aileron wires shown in Complainants' Exhibit "Drawing of Defendants' Machine," please so state? 776

A. In all of the experiments, a movement of the ailerons produced by moving the shoulder frame, or the movement of the ailerons, was the same as in Complainants' Exhibit "Drawing of Defendants' Machine."

Recess for lunch, at 1:00 P. M., to 2:00 P. M.

777

Resumed at 2:10 P. M.

Q112. In flying your machine and in ordinary balancing by the use of the ailerons, roughly about how long are the ailerons held at their moved position?

> By Mr. Toulmin: Objected to as misleading or confusing, because it is the whole movement of the ailerons from the

778 starting position to the extreme and back again which is functional, and not the time they rest at the extreme of their movement. The Court will kindly note the underlying principle.

A. The time required to operate the ailerons sufficiently to balance the machine in suit is usually only a fraction of a second. The ailerons seldom remain at the greatest angle to which they are moved to regain balance any appreciable length of time at all.

Q113. About how many inches laterally do
779 you move the shoulder frame in balancing?

A. About two or three inches in either direction.

Q114. What happens in regard to the shifting of the line or center of pressure on a flat surface when its angle of inclination is changed, and what happens when the angle of inclination remains the same but the speed is varied?

A. The line or center of pressure on a flat surface when inclined at a slight angle to the wind is very close to its front edge. When the angle or inclination is increased the center of pressure travels quickly back to near the center
780 of the flat surface. If the flat surface is inclined at a fixed angle to the wind and the velocity of the wind or the speed of the flat surface through the air be varied, the center of pressure will travel forward as the speed increases and backward as the speed decreases.

Q115. Assuming a machine built as shown in the drawings of the patent in suit (which I show you) and with the ribs straight, the only curvature being due to whatever bagging or looseness there might be in the cloth between the

ribs, and with the vertical rudder permanently 781
connected up to the warping wires, would you consider it a practical flying machine?

> By Mr. Toulmin: Objected to as no foundation has been laid to show that the witness is in a position to know what was asked, or to have anything but a speculation on the subject.

A. The machine shown in the drawing would not, in my opinion, be a practical flying machine.

Q116. The only curvature on the main supporting surfaces described in the patent is, I believe, the portion in the left-hand column of page 5 782
near the bottom, which states

> "although, of course, when constructed of cloth or other flexible fabric, as we prefer to construct them, these surfaces may receive more or less curvature from the resistance of the air, as indicated in Fig. 3."

The cloth, if there was any looseness in it, would be susceptible of "bagging." What effect would this have if the bagging amounted to much?

A. I don't know what you mean by "effect." 783
Do you mean efficiency of such a surface?

Q117. Well please answer as to that.

A. I would consider a flat surface or frame with a loose or baggy covering a very inefficient and unsatisfactory construction for use in an aeroplane.

Q118. What effect, if any, would the shifting in the center of pressure have on such a looseness or bagging of the fabric?

> Objected to as wholly immaterial as the patent does not say that the cloth is to be loose or to have "bagging."

1217

784 A. It is the custom of all aeroplane manufacturers to stretch the cloth as tightly as possible over the frame of the wings. If the cloth becomes loose through having stretched, it is usually removed and a new covering put on, as a loose covering is considered inefficient and dangerous. The shifting of the center of pressure would tend to wear out the covering and tear it loose from the frame, and the machine with a loose or baggy covering would be very unsatisfactory as a flying machine.

Q119. You have said that the line or center of pressure on a flat surface shifts as the inclina-
785 tion or speed varies. If there was any looseness in the cloth, would the curvature of the cloth due to the air pressure change when the angle of inclination or the speed is varied?

A. I believe it would change somewhat.

Q120. The patent in suit states that when the wings are warped it

> "gives the machine a tendency to turn around its vertical axis, and this tendency if not properly met will not only change the direction of the front of the machine, but will ultimately permit one side thereof to drop into a position vertically below the other side with
> 786 the aeroplane in vertical position, thus causing the machine to fall,"

and it further describes the rear rudder as used to check or counteract this turning and disastrous result which would otherwise occur.

As the rudder wires or cables are described and shown as connected to the cables which warp the wings, a given warping of the wings would obviously turn the rudder a certain amount. With the rudder set a certain distance behind the machine this might sometimes counteract such turning of the machine.

What would be the effect if the rudder were 787
set further back than that point just sufficient to check such turning of the machine?

A. The effect in such an event would be that the rudder would not move sufficiently to check the turning.

Q121. Assuming that the rudder was set in such position that (with a given angle of incidence on the main planes) a certain amount of warp given to the wings would be exactly counterbalanced by the amount the rudder would be turned by such warping. What then would be the effect if the angle of incidence on the main planes changed, such as by varying the speed of 788
the machine or varying its angle of incidence?

A. If the rudder were set just right to exactly counteract the turning effect caused by the warping, the machine could only fly in a straight line. If the angle of incidence of the planes changed sufficiently during flight so that the set of the rudder did not match the increased resistance on one wing and the decreased resistance on the other, the machine would tend to turn toward the side of greatest resistance. A machine of the type shown in the patent in suit in which the main supporting surfaces are warped would not be a practical flying machine if the wires or cables 789
operating the rear vertical rudder were attached rigidly to the wires or cables operating the warp.

Q122. Does any one of the various makes of practical flying machines with which you are acquainted have the vertical rudder connected in such a manner that it cannot be moved except by means of the cables or wires which warp the wings or move the ailerons?

A. No manufacturer uses this construction, and as I have stated, a flying machine would not be practical if constructed in this manner.

790 Q123. Do the complainants' machines have the construction mentioned in the last question?

A. None of the complainants' machines which I have seen have the construction mentioned, and I understand they have never used it in their practical flying machines.

Q124. What would happen to the machine of the patent in suit if the rear vertical rudder did not exactly counterbalance the difference of resistance on the two wings when they were warped, assuming that the machine could be rocked from one side to the other and back again by warping the wings. Would the machine move straight ahead,
791 or what would happen?

A. What happened would depend entirely on what position the vertical rudder was set relative to the warping. If the vertical rudder was set exactly right, the machine should continue in a straight line, provided no other forces or elements came into play. If the rudder were set at a point insufficient to counteract the swerving, then the machine would swerve to whichever side the resistance was created by increasing the angle of incidence of the wind.

Q125. In operating your machines and flying say 40 miles an hour, driven by a motor, when you meet
792 a change in the air, such for example as a current having a rising trend, does the machine go plunging through it in its original line of flight, or does the machine yield to this change?

A. A machine very quickly adjusts itself to the varying conditions of air to which it comes in contact, and does not continue in a straight line regardless of the variations of the wind.

Q126. Supposing you meet such a rising trend of wind and do not change the adjustments of the machine at all, will the machine rise somewhat or not?

A. If the movement of air was of a sufficient velocity and duration, the aeroplane would rise somewhat. 793

Q127. If we should assume a machine flying directly north in perfectly still air, and it should meet and run into a current of air from the northeast, would the rush of air toward the machine (after it had gotten into the northeast current) appear to the aviator to be blowing from the northeast, or would the rush return directly in his teeth, that is, directly opposite to his course through this new body of air?

A. The rush of air in an aeroplane is always directly opposite to the line of flight. An aeroplane 794
is sustained in the air by being forced forward at a given speed and angle of incidence relative to the air, and as I have said, quickly adjusts itself to any new condition. The only way the aviator can tell which way the wind is blowing is by noting the drift of the machine over the ground, or by observing some object affected by the wind and not a part of the aeroplane.

Adjourned at 4:30 P. M. to Sept. 29, at 10:30 A. M.

New York, N. Y., Sept. 29, 1911, 795
10:45 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

Q128. In flying through the air in a power-driven machine the direction of the air rush, you have said, is directly opposite to the true course of the machine through the air. Supposing that you meet a change in the air such as, for example, 796 a wind having an upward trend. Do you or do you not detect any change of the air rush?

A. In flying an aeroplane I cannot detect a change in the direction of the wind or rush of air under the conditions you describe, or any other condition. An aeroplane moves with the current of air in which it is poised and so quickly changes its line of travel to meet any changing conditions of the air, that no change in the direction of the air rush can be detected by the aviator.

Q129. Supposing that you are turning on a curve with your rudder set over so as to cause the machine to take the curve, and with the machine some-
797 what tilted so that the wing on the inside of the curve is lower than the outside wing. Supposing then that while so turning the machine loses its equilibrium in one direction or the other so that you have to use your ailerons to right the machine. Is or is it not necessary to change the set of the rudder, that is, the angle to which it was turned.

A. It is not necessary to use the rudder under the conditions you mention, any more than if the machine were flying in a straight line. The balance of the machine is regained, if lost, by a slight movement of the ailerons. By "balance of the machine"
798 I mean proper poise with respect to the circle which was being turned.

Q130. Such balance might be lost and have to be regained in either or both directions during a turn. Is that correct?

A. That is correct. The machine is just as liable to become inclined at too great an angle as it is at too little an angle from the horizontal while making a turn.

Q131. Can you name any makes of flying machines which at the present time operate their rear vertical rudders by a lever or bar which is operated

by the feet of the aviator. If so, please name some 799
of them?

A. The Bleriot and Farman are operated in this manner.

Q132. Mr. Hammer, one of complainant's witnesses, has spoken of the Voisin machine. How does this machine accomplish restoration of equilibrium, if you know?

> By Mr. Toulmin: It does not appear to the witness that the witness has ever attempted to fly in a Voisin machine. His answer should be understood accordingly.

A. The method of operation of the Voisin ma- 800
chine of the type referred to by Mr. Hammer is well known. This machine is steered by a rear vertical rudder, and the operator depends upon the low center of gravity and the large amount of vertical surface purposely fixed between the posts of the main planes for his lateral balance. If these factors do not act sufficiently to keep the machine from tipping too much, it may be brought back to an even keel by steering in such a direction that the speed of one wing through the air will be increased, thereby increasing the lift. This would produce the opposite effect upon the opposite wing, causing
it to drop, thereby bringing the aeroplane back to a 801
level.

Cross examination by Mr. Toulmin:

XQ133. Lieutenant Ellyson and Captain Beck who testified as witnesses for defendants in this case, have been flying Curtiss aeroplanes at the Nassau Boulevard Aviation Meet, which has been in progress in this community about a week past. Will you state whether the machines they have been using belong to you, or any Company in which you are interested?

802 A. The machine which Lieutenant Ellyson is using is owned by a gentleman from Atlanta, Georgia, and I do not know under what arrangements Lieut. Ellyson is using the machine. Captain Beck is using a machine which he leased from The Curtiss Exhibition Company, especially for the purpose of competing in this Meet.

XQ134. Has the Curtiss Exhibition Company any interest in the proceeds or prize money which Captain Beck has won or may win in these competing flights at Nassau?

> By Mr. Newell: Objected to, as The Curtiss Exhibition Company is not a party to
> 803 this case, especially as it was formed long after this suit was started. The witness is instructed that he is not obliged to answer the question.

A. I am not sufficiently informed on the subject to answer the question definitely.

XQ135. What is your connection with The Curtiss Exhibition Company?

> Same objection and instructions to the witness.

A. I have no objection to answering this question,
804 but if this line of inquiry is immaterial, I will not answer it, by advice of counsel.

XQ136. I have a right to ascertain your relations to The Curtiss Exhibition Company and the relations of Captain Beck with that Company in connection with the machine or machines of the Curtiss make which he is using. So the questions are material, in my judgment, and I again ask you to state what your relations are with The Curtiss Exhibition Company?

> By Mr. Newell: Without waiving the objections to this question, if counsel merely wishes to find out what relation Mr. Curtiss

and Capt. Beck have to the Company, I do 805
not care to interpose any objections to this
specific inquiry, but as to anything else, I do
object unless its materiality and propriety
is shown.

By Mr. Toulmin: I decline to have my cross examination limited in this manner, and will therefore ask such questions as I deem proper, insisting upon answers, leaving the responsibility to opposing counsel for any instruction he may give the witness.

A. I am officially the Secretary and Treasurer of
The Curtiss Exhibition Company. 806

XQ137. And a stockholder?

A. Yes, I am a stockholder.

XQ138. And the Company bears your name?

A. The corporation title is The Curtiss Exhibition Company.

XQ139. And the name "Curtiss" in the corporate title is taken from your name, or is your name. Is that correct?

Same objections to this line of examination, and it is understood that this objection is given without repeating it.

A. I should say that the name "Curtiss" was 807
used because the Company is exhibiting mostly
aeroplanes of that name.

XQ140. As Secretary and Treasurer of The Curtiss Exhibition Company, do you mean to say that you do not know and cannot state whether the lease taken by Captain Beck from The Curtiss Exhibition Company for the use of the Curtiss machine he is flying at the Nassau Meet provides for a part of the proceeds the Captain may obtain through the use of the machine, shall go to the Curtiss Exhibition Company?

A. It is possible that the sum paid, if any, by

808 Captain Beck for the use of the machine is determined by his winnings or losses as a result of the contests. I did not draw up the lease and I am not able to state absolutely what the arrangement is

XQ141. Is not the lease which he took the same, or substantially the same, lease which the Company gives other aviators who fly Curtiss machines under similar conditions, that is for prize money at Exhibition Meets?

By Mr. Newell: This line of examination is going way beyond what counsel is entitled to. Even if what is now being inquired about were true, it would have no bearing on
809 this case as set out in the bill of complaint. The witness is instructed that he need not answer this question, or any question which is not specifically confined to Captain Beck's personal connection, if any, with the Company, until the propriety of the questions are shown.

A. As I said before, I cannot tell you the terms of the lease of the machine which Captain Beck is using.

XQ142. Well do you mean to tell the Court in this case that you do not know, as Secretary and
810 Treasurer of The Curtiss Exhibition Company, whether or not that Company shares in the proceeds of the money prizes Captain Beck has won or may win by flying this Curtiss machine?

Same objections and instructions.

A. Your deductions are correct. I do not know the terms of the lease, and I do not know if the Company will receive any money from Captain Beck as a portion of his prizes or not.

XQ143. Then will you say that this machine has in fact been loaned to Captain Beck for his use in making exhibition flights for prize money,

and that the so-called lease, you have spoken of, 811
is merely formal?

A. I have been told that Captain Beck signed a lease for the use of this machine, and I heard him talking with someone about the possibility of his breakage or damage due to accident exceeding his winnings. This is why I said I don't know if the Company will get anything or not.

XQ144. I did not ask you whether the Company would get anything or not, but merely whether Captain Beck was to pay to your Company a portion of any proceeds he may realize as prize money or otherwise from the use of this machine? Please
answer that. 812

A. I can say that barring accidents, Captain Beck will pay the Company for the use of the machine.

XQ145. When did this arrangement with Captain Beck go into effect?

A. I think just before the Meet commenced, that was Saturday, September 23rd, 1911.

XQ146. Is Captain Beck on a leave of absence at this time, and has he been during the time since the date of the arrangement?

A. I understand that Captain Beck is on leave.

XQ147. Has The Curtiss Exhibition Company,
or have you personally, any similar arrangements 813
with any other Army or Naval Officers?

A. Not to my knowledge.

XQ148. You say that Lieutenant Ellyson has been using at this Nassau Meet a Curtiss machine owned by some one living in Atlanta, Georgia. Has Lieut. Ellyson been operating that machine under substantially the same terms as Captain Beck has been operating under, only that the terms apply first between Lieut. Ellyson and the owner of the machine, and then from the owner to you or your Company?

Objected to as immaterial and secondary.

814 A. I have no knowledge of Captain Ellyson's arrangement in regard to this machine, but our Company has no interest in it.

XQ149. You mean no interest in proceeds which Lieut. Ellyson may win?

A. I mean that the Company has no interest in the proceeds Lieut. Ellyson may win, and no interest in what he may pay for the use of this machine.

XQ150. But will not a share of Lieut. Ellyson's earnings come to your or your Company as a use of the machine, but come through the Atlanta owner of the machine in his accounting with you
815 or your Company?

Same objections.

A. I think my last answer is sufficient to show that our Company has no interest from a financial point of view in what Lieut. Ellyson may do with the aeroplane.

XQ151. But if this Atlanta owner were flying the machine under the same circumstances as Lieut. Ellyson is now flying it, you or your Company would have a share in any proceeds the owner might realize, would you not?

816 By Mr. Newell: This outrageous excursion outside of anything connected with the case is becoming ridiculous. The witness is instructed that he need not answer the question.

By Mr. Toulmin: I need not do more than ask the Court to note the attitude of opposing party.

A. It is difficult to get the meaning of your question. I can only answer that not knowing Lieut. Ellyson's arrangements with the owner, I do not know what position our Company would be in if it were in the same position with respect to the owner of the machine, that the owner is with respect to Lieut. Ellyson. 817

XQ152. Well, if the Atlanta owner of this machine were flying it for money prizes, would you or your Company have a share in the proceeds?

> Same objections and instructions. How proof of this, even if true, could prove or in any way tend to prove the allegations of the Bill of Complaint is not apparent.
>
> By Mr. Toulmin: It is not necessary to follow the averments of a bill in order to test the relations of witnesses to the party in whose behalf we are testifying. 818
>
> By Mr. Newell: The averments of the Bill of Complaint are the matters which are to be proved or disproved in this case. The Bill of Complaint alleges the joint infringement by The Herring-Curtiss Company and Mr. Curtiss only. I cannot see how this line of examination now indulged in has any bearing on the matter, and I wish it to be thoroughly understood that I object to it, even though I do not put down an objection after each question. However, the witness is instructed that he need not answer such questions as the foregoing, until otherwise instructed by the Court. 819

A. I refuse to answer the question, upon advice of Counsel.

XQ153. And would not you or your Company receive a share of the proceeds of any prize money won by the use of this machine whether the owner flew it, or Lieut. Ellyson flew it for the owner, the machine in either case being flown and prize money won?

A. They would not.

XQ154. Has Lieut. Ellyson been on a leave of

820 absence during his use of this machine in this Meet?

A. I believe he has.

Adjourned for lunch at 1 P. M. to 2 P. M.

Resumed after lunch at 2 P. M.

XQ155. I have here a certified copy of a certain complaint which reads as follows:

SUPREME COURT,

STEUBEN COUNTY.

821 GLENN H. CURTISS,
Plaintiff,

against

CHARLES K. HAMILTON,
Defendant.

The plaintiff complains of the defendant and shows to this Court:

(1) That at all times herein mentioned plaintiff was and still is a resident of Hammondsport,
822 Steuben County, N. Y., and that the defendant was and is a resident of New Britain, Conn.

(2) The plaintiff further shows, upon information and belief, that before this action was commenced defendant became justly indebted to plaintiff in the sum of $6,513.63, for rent of plaintiff's aeroplane, pursuant to and under a written contract made between the parties hereto, dated the 17th day of November, 1909, whereby defendant agreed to fly the said aeroplane and give exhibitions under the direction of this plaintiff, and whereby defendant agreed to pay for the use of

said machine, as rental therefor, 60% of the net proceeds of each and every contract for exhibition, and that the defendant exhibited said machine and made flights therein at several exhibitions specified by or under the direction of this plaintiff and 60% of the net proceeds of the same, at the time this action was commenced amounted to $6,513.63, and became and were due, by the terms of said contract as fast as the price for such exhibitions were paid, and that the price for said exhibitions had been paid before this action was commenced, so that 60% thereof was the sum above stated, and that said sum is now wholly due and unpaid. 823 824

(3) Plaintiff for a further cause of action against the defendant shows that before this action was commenced, and on or about the 15th day of June, 1910, at the City of New York, plaintiff and defendant had an accounting as to the rental and expenses of operating a certain aeroplane belonging to plaintiff, and which defendant used and exhibited under a written contract made between the parties hereto, and that an account of the plaintiff and defendant was thereupon stated, whereby the defendant agreed to pay to the plaintiff at that date, as and for an account stated, the sum of
$3,478.63 and it was thereupon agreed at said time 825
and place between the parties hereto that this defendant was indebted to and owed this plaintiff the sum of $3,478.63, which sum the defendant undertook and agreed to pay plaintiff, all of which became due before that date and before this action was commenced.

Wherefore plaintiff demands judgment against defendant for $6,513.63, with interest thereon from this date, besides his costs of this action.

Dated June 30th, 1910.

(Signed.) MONROE WHEELER,
Plaintiff's Attorney,
Bath, N. Y.

826 State of New York, } ss.:
County of Steuben, }

Glenn H. Curtiss being duly sworn says: I have heard read the foregoing complaint and know the contents thereof, and the same is true to my knowledge, except as to the matters therein stated to be alleged upon information and belief, and as to those matters, I believe it to be true.

GLENN H. CURTISS.

Sworn to before me this 30th }
day of June, 1910. }

S. D. French,
827 Notary Public.

Endorsed: Filed Jan. 11, 1911.

JOHN E. OLMSTED,
Clerk.

State of New York, } ss.:
County of Steuben, }

I, John E. Olmsted, Clerk of said County, and also Clerk of the County and Supreme Courts therein, Courts of Record, do hereby certify that I have compared the foregoing copy of a complaint with this original on file of the same now remaining in my office, and that it is a correct transcript
828 therefrom and of the whole of said original.

In testimony whereof, I have hereunto set my hand and seal of said County and Court, at Bath, this 19th day of September, A. D. 1911..

JOHN E. OLMSTED,
Clerk."

Inspect this certified copy. This complaint was signed and sworn to by one Glenn H. Curtiss of Hammondsport, N. Y. Are you that Curtiss?

Counsel for defendants objects to this question and the insertion of this complaint on the ground that it is entirely improper cross examination. No basis having been laid therefor in the direct testimony of the witness. This is therefore going into matters which the complainant is not entitled to prove at the defendants' expense. The witness is therefore instructed that at the present time he need not answer the question. 829

By Mr. Toulmin: The Court is asked to note the method pursued, which has the effect of practically destroying the right of cross examination. The matter now presented to the witness goes to a question of credibil- 830
ity, which may always be tested at any stage of the case and hence an answer to the last question is insisted upon.

By Mr. Newell: I have no objection to your examining the witness on any proper matters, but until it is shown how this may have any bearing on the credibility of the witness (if that is your only point to bring out by this line) the witness need not answer the question, as its materiality does not appear.

By Mr. Toulmin: The record now shows that the purpose of the question has refer- 831
ence to the credibility of the witness. This is sufficient notice, if any notice were required, before the answer was given, so that the answer is now insisted upon.

By Mr. Newell: Your mere statement that it is material, in your opinion, to the credibility of the witness is not sufficient. Until you show its materiality by something else than by your mere opinion, the question is improper for the above reasons.

832 A. Following advice of counsel, I refuse to answer.

XQ156. I have here a certified copy, certified to by Harris S. Williams, Clerk of the Court in which this cause is pending, of an affidavit signed and sworn to on the 18th of March, 1910, and filed in this cause on the 19th of March, 1910, by one Glenn H. Curtiss. Are you that Glenn H. Curtiss? Inspect the certified copy, the affidavit being entitled in this cause.

By Mr. Newell: I have looked at the copy handed to the witness, and while I cannot see that this, even together with the alleged
833 copy of the complaint embodied in XQ155, affects in any way the credibility of the witness when the language used in the affidavit is read, I do not wish to have any erroneous impression created, and therefore instruct the witness that, in view of XQ156, he may answer XQ155 as well as XQ156, but without waiving any right of objection to further examination on this line if it shall prove to be improper cross examination.

A. Answering XQ155, I am that Glenn H. Curtiss. In answer to XQ156, I am that Glenn H.
834 Curtiss.

Counsel for complainant offers in evidence a certified copy of the complainant of Curtiss against Hamilton, and the same is marked Complainant's Exhibit "Curtiss Hamilton Complaint."

He also offers in evidence a certified copy of the Curtiss affidavit referred to, and the same is marked Complainant's Exhibit "Curtiss Affidavit March 18, 1910."

Notice is given that should occasion require the original of the Curtiss affidavit of March 18, 1910, now on file in this Court, will be made use of on the hearing of this cause, as for instance should the certified copy now offered in any manner become lost. 835

By Mr. Newell: Objection is made to the exhibit first mentioned if used for any other purpose than affecting the credibility of the witness, on the ground that its use for any other purpose would be improper at this time. If intended for use for any other purpose, it is improper as it should have been introduced as part of complainant's *prima facie* case. 836

Cross Examination Closed.

Redirect examination by Mr. Newell:

RDQ157. Is Lieut Ellyson or Captain Beck a stockholder, or have either of them ever been stockholders, in The Curtiss Exhibition Company?

A. Neither Lieut. Ellyson or Captain Beck are stockholders, or are they in any way financially interested in The Curtiss Exhibition Company, nor have they ever been.

G. H. CURTISS.

Mr. Newell states that the cross examination of Mr. Curtiss has been so short that I have no other witness to put on now. The Notary states that she will have to be away on Monday, October 2nd. Adjournment is therefore taken to Tuesday, October 3rd, to 10:30 A. M. with the understanding that if Dr. Zahm is not put on as a witness at said time, no other witness will be put on until Wednesday, Oct. 4th. 837

838 New York, N. Y., October 4, 1911,
11:00 A. M.

Present—Counsel as before.

AUGUSTUS POST, a witness heretofore introduced and having testified in behalf of defendants being recalled deposes and says in answers to questions by Mr. Newell:

Q1. You are the same Augustus Post who has heretofore testified in this cause?

A. I am.

Q2. If you ever saw Mr. Glenn H. Curtiss make a flight with the rudder wires disconnected
839 from the rudder, please describe it and state when it occurred, roughly?

A. I witnessed such a flight in February, a year and a half ago. This flight was made on the ice and over the surface of Lake Keuka at Hammondsport, New York. The rudder wires were disconnected at the rudder from the vertical rudder in the rear of the similar type of machine described in this case, and a flight was made of a quarter of a mile straight-away. Balancing was affected by the use of the balancing planes on the machine, and the machine finally landed in a proper manner in order to avoid ob-
840 structions, and there was no turning or swerving out of the course by this machine upon this occasion.

By Mr. Toulmin: The objections as to *ex parte* tests are here repeated as to this witness.

Q3. What machine was used?

A. The machine as shown in the photograph marked Defendants' Exhibit "Post Photograph No. 1."

Q4. You say that the rudder wires were dis-

connected at the rudder. Was the rudder fixed 841
in position, or could it turn by any action of the wind on it?

A. The rudder was not fixed, but was free to move by any action of the wind.

Q5. Could the rudder be moved by Mr. Curtiss in any way during that flight? A. It could not.

Q6. If you were watching to see whether or not any particular thing occurred or did not occur during this flight, please say what it was?

A. I was particularly observing as to whether the machine would swerve, that is, turn about a
vertical axis during such times as the balancing 842
planes were used, and I distinctly observed that such was not the case.

Cross examination by Mr. Toulmin:

XQ7. You say this flight was made on the ice. Was the machine first tried in that experiment by allowing it to run along on the ice instead of rising from the ice?

A. This flight was made above the surface of the ice, and the machine was not run on the surface of the ice any further than the usual distance required for rising into the air, and
no preliminaries were made. 843

XQ8. About what distance above the ice surface did the machine travel?

A. I should say between 30 and 50 feet.

XQ9. Was the flight made both ways over the course, or one way only?

A. The flight was made both ways. The one to which I refer was in one direction, and the return flight was substantially the same.

XQ10. Substantially the same in what particulars?

844 A. In regard to the flight of the machine without swerving and with the rudder disconnected.

XQ11. Does the expression "substantially the same" include or refer to slight lateral variations in the course of the machine on the return flight?

A. If you mean by "lateral variations" the balancing of the machine, the machine was balanced. There was no swerving of the machine around a vertical axis caused by its process of balancing.

XQ12. Was there any swerving or turning on a vertical axis at all independently of what might
845 have been the cause?

A. There was no swerving or turning of the machine independently of this cause.

XQ13. Do you recall about how far the machine landed on the return trip, to either side of the starting point of the first trip?

A. The machine came back to the starting point of the first trip.

XQ14. And were the ailerons or balancing planes quite constantly adjusted first in one direction and then in the other in quick succession?

A. The balancing planes were operated at
846 such time as they were required to be operated, and this occurred under my observation several times, but I would not say that they were constantly operated in one direction and the other direction as your question seems to imply.

XQ15. Well, were they quickly operated from one position to the opposite position more or less in each of these short flights?

A No, it did not seem to me that they were unduly used, but it appeared that they were used in the ordinary manner that would be required by a flight such as this was. The disconnection of the rudder did not seem to effect, and did not effect, the operation of balancing. 847

XQ16. Could you see the extent or amplitude of the adjustments of the ailerons?

A. I could see the adjustment of the balancing planes when they were used by Mr. Curtiss.

XQ17. Was it a calm day, or calm during the time of these two experimental flights?

A. It was an ordinarily calm day.

XQ18. Then the loss of lateral balance of the machine was small in extent, was it not?

A. The machine flew and it could be observed to tilt to one side or the other, and it was restored to its state of equilibrium by the operator using the 848
balancing planes.

XQ19. But my question was as to whether the loss of lateral balance or tilting was slight in view of the state of the weather you have mentioned. Please state as to that if you observed this feature?

> By Mr. Newell: Slight as compared with with what?
>
> By Mr. Toulmin: I prefer to have the witness answer the question.
>
> By Mr. Newell: The question is ambiguous as it stands, and the witness is instructed that he may explain his answer so as to 849
> show just what standard of comparison the witness has in mind in making his answer.
>
> By Mr. Toulmin: I call the Court's attention to the impropriety of Counsel, in effect, directing the course of the answers by instructions to the witness. The office of redirect examination provides for clearing up any uncertainty, if there be any, of the answers on cross examination.

A. At such times as the machine lost its balance, it was corrected by the use of the balancing planes, 850 there were unevennesses in the conditions of the air during this period, and the machine was flown in the same manner that it would have been flown under any other circumstances by the same operator. Your term "slight" is a little vague to my mind, because any loss of equilibrium if unchecked may be no slight matter irrespective of the state of the weather.

XQ20. Still you have not really answered the question. If you observed the extent of the tilting of the machine during the brief periods it was in the air on those two experimental flights, please state whether the tilt was small in extent, or large,
851 compared with conditions when the weather is not in the state you have said it was in upon those occasions?

A. The tilting of the machine due to the loss of balance occurred to an appreciable extent and was properly corrected, and I have seen machines fly in high winds even with greater steadiness than occurred upon this occasion, and the state of the wind does not necessarily govern the amplitude of the tilting of the machine.

XQ21. But you are not prepared to state the amplitude of the tilts in degrees of the machine during the few seconds it was in the air on each of
852 those experimental flights, are you?

A. I did not measure the degrees of tilting, but it was clearly evident that the machine did tilt and the action of the balancing planes could be clearly seen, and the duration of the flight was of sufficient length to clearly demonstrate these points, and it was not as brief as your question would seem to imply.

XQ22. Well, how many seconds do you say the machine was in the air on each of the flights, counting from the time it cleared the ice until it retouched in landing?

A. I did not time the flight of the machine as this was not an element or essential in the case. The distance was about a quarter of a mile and the machine rose after a very short run and flew clearly in the line of vision, giving ample opportunity to observe the points mentioned and landed at the end of the flight on the surface of the ice. 853

XQ23. Did you observe about how many times the balancing planes were operated in recovering lateral balance in each of the flights?

A. I did not count the number of times that the balancing planes were used. My attention and observation was directly focused upon the fact
as to whether the machine swerved or turned about 854
its vertical axis at such times as these balancing planes were used, and it was clearly observed that no such turning about the vertical axis was caused when the balancing planes were operated.

XQ24. Was there any such turning when the balancing planes were not being operated to recover lateral balance?

A. No, there was no turning about the vertical axis observable at such time as the balancing planes were not used.

XQ25. You say there was "no turning about the vertical axis observable," when the balancing
planes were not being operated. Does the same 855
answer apply, that there was no turning on the vertical axis observable when the balancing planes were operated?

A. My answer to XQ23 states that "it was clearly observed that no such turning about the vertical axis was caused when the balancing planes were operated."

XQ26. Well, as you were not on the machine during either of those flights, you are here testifying to what you observed from the ground or ice, are you not?

856 A. I am testifying to what I observed upon this occasion, and I am endeavoring to answer the questions which are put.

XQ27. Then your testimony is to the effect that you did not observe any turning of the machine on the vertical axis during either of those flights. Is that substantially correct?

A. There was no turning of the machine about its vertical axis upon these flights either when the balancing planes were used or were not used. If there had been any, I would have observed it.

XQ28. And you say that you did not observe any?

857 A. I did not observe any, because there was none to observe.

XQ29. And you base your statement that there was no such turning or swerving on your observation as made at that time. Is that correct?

A. I base my statement upon the facts as stated.

XQ30. And these "facts" you base upon your observations, do you not?

A. The facts speak for themselves. My observations are based on the facts.

XQ31. Did you attend Mr. Curtiss on the occasion of these two tests for compensation for your time, or merely in a friendly capacity?

858 A. I did not attend Mr. Curtiss for compensation.

Redirect examination by Mr. Newell:

RDQ32. What, if anything, did Mr. Curtiss tell you why this flight was not mentioned in the papers on the motion for preliminary injunction?

Objected to as incompetent.

A. He said all machines are entitled to a rudder.

RDQ33. In your answer to Q2 you said that the flight was made "on the ice and over the surface

of Lake Keuka." Did you mean that the flight was 859
made over the water, or only over the ice?

A. This flight was made above the surface of the Lake which was frozen at that time.

AUGUSTUS POST.

Adjourned at 12:40 to 2 P. M.

Resumed at 2 P. M.

Present—Counsel as before.

By Mr. Newell: Notice is hereby given that next Tuesday, October 10th, 1911, at
the Court room in Buffalo, New York, at 860
the opening of the Court or so soon thereafter as counsel can be heard, a motion will be made for an extension of defendants' time now set for taking its testimony.

ALBERT F. ZAHM, a witness introduced on behalf of the defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence and occupation?

A. Albert F. Zahm; of mature age; residence,
Washington, D. C.; occupation, scientific research 861
and writing.

Q2. You are the same A. F. Zahm who executed an affidavit on behalf of the complainant on the motion for preliminary injunction, and also one for the defendants?

A. Yes.

Q3. Will you please state what, if any, experience you have had in the theory and practice of aeronautics, and what if any, qualifications in making calculations in regard to aeronautical matters?

862 A. In the theory of aeronautics I have read the standard literatue of the subject and have made original investigations and inventions; in the practice of aeronautics I have helped to design aeroplanes, have attended experiments of various kinds with aeroplanes, and have witnessed numerous flights with various types of such machines under various atmospheric conditions.

As to my qualifications for making calculations, I have all the training in theoretical and applied mechanics and physics comprised in the regular mechanical engineering course given at Cornell University and in the regular course for the de-
863 gree Doctor of Philosophy in Physics given at the John Hopkins University; furthermore, I have for several years taught advanced courses in mechanics and physics to graduate students, and have made special researches in aerodynamics bearing directly upon calculations in aviation. I have made many experiments on wind-pressure, the lift and drift of different surfaces and the atmospheric friction on them. I was General Secretary of the International Aeronautic Congress, held in 1893 at Chicago; an Official American Delegate to the International Aeronautic Congress at Paris in
864 1900; General Secretary of the International Aeronautic Congress held at New York in 1907; am now Secretary of the Aero Club of Washington; a charter member of the Aero Club of America; author of a treatise on Aerial Navigation recently published by D. Appleton Company of New York, and of various original researches and papers on aerodynamics.

Q4. I hand you Defendants' Exhibits "Curtiss Photographs Nos. 1, 2 and 3, and ask you if you recognize them?

A. Yes.

Q5. Please state who the persons are in the photographs and what the device is which is there shown. 865

By Mr. Toulmin: Objection as to *ex parte* tests and testimony relating to them is renewed once for all.

Now that the sheet containing the notice of the proposed motion is out of the typewriter and I have read it, I call attention to its insufficiency because the grounds upon which the motion is to be made are not stated. It is requested that counsel state the grounds within the next few days.

By Mr. Newell: The general ground is 866
that I cannot complete the testimony within the time now limited.

A. The persons in the photographs #1 and #2 are Mr. Curtiss and myself.

The apparatus mounted on the front of the hydroplane boat there shown is the same as the apparatus exhibited in Photograph #3 and consists substantially of two ailerons fastened by their front edges to a three-quarter inch horizontal steel pipe lashed to a vertical kingpost, 6 to which they are suitably trussed by guy wires holding them at any desired angle one to the other. 867
The object of this apparatus was to determine the difference of drift, if any, on two equal ailerons moving through the air at the same velocity and set at equal angles of incidence, positive and negative, and when having different angles of incidence. The apparatus was mounted on the hydroplane boat I with the king-post pivots resting in sockets at the top and bottom, the lower socket being merely a hole in a supporting plank and the top socket being a like hole in a bamboo stick 8 protruding from the top surface of the aeroplane and suitably trussed to prevent vibration. Greased

868 washers supporting the lower pivot were used to diminish the resistance to turning of the king-post, should unequal wind pressures be experienced by the ailerons. In order to measure such difference of resistance, a lever-arm 4, nine inches long on each side of the center of the king-post was attached at right-angles to the king-post, and to one end of this lever springbalances 7 (see Photo. #2) were attached pulling oppositely to each other in the same straight line and perpendicularly to the lever-arm 4. Above the ailerons was mounted a vertical wind-vane 3 graduated to serve as a protractor and having at the center of the pro-
869 tractor circle a screw carrying a silk thread to show the direction of the air rush. A Warner cup anemometer 5 mounted on the front of the aeroplane well above the lower surface was used to indicate the velocity of the wind.

I made two runs with Mr. Curtiss in the hydroplane with the apparatus attached as above described. Going from the shore, when the hydroplane was well under way, I made the following observations; speed of air recorder by anemometer, thirty miles per hour; position of silk thread on wind-vane three degrees above median line; displacement of spring balance pointer one pound.
870 This latter reading must be doubled because two spring balances are attached to the one string.

Returning toward the shore at steady speed the readings were as follows: Wind speed 35 miles an hour, position of silk thread on wind vane four degrees above the median line, displacement of spring-balance pointer one and one-half pounds, which doubled equals three pounds change of tension. On the second run from the shore when well under way I made the following readings: Speed indicated by anemometer 30 miles an hour; position of silk thread above median line four degrees;

displacement of spring balance indicated one and 871
two-tenths pounds, equal to two and four-tenths pounds change of tension; also the following readings: Wind speed 35 miles per hour, angle of silk thread above median line four degrees, displacement of spring balance one and seven-tenths pounds, equaling three and four-tenths pounds for both scales. Returning toward shore on the second run the following steady readings were obtained: Anemometer 35 miles per hour, silk thread four degrees above median line, spring balance displacements one and a half pounds, equaling three pounds for both scales.

By "median line" is meant a line bisecting the 872
angle made by the chord planes of the ailerons, or a parallel line to this passing through the center of the protractor where the silk thread was attached. During the foregoing observations the ailerons were set at an angle of about 21.5 degrees with respect to one another; more exactly the lines of their rear edges were nine inches apart, the ailerons themselves being 24 inches wide.

For convenience of reference, the above results are tabulated as follows:

873

Speed of Hydro aeroplane miles per hour	Uprush angle of air	Tension on scale
30	3°	2 lb.
35	4°	3
30	4°	2.4
35	4°	3.4
35	4°	3

The distance from center to center of the ailerons was 87 inches, one-half of which multiplied by the difference of drift on the ailerons equalled the moment exerted by the spring balance on the lever nine inches long. Hence multiplying the figures

874 in the last column of the table by 9 and dividing by 43.5 gives the difference of drift on the ailerons.

In the foregoing experiments, as will be observed, the direction of air rush was inclined upwards three to four degrees above the median line of the ailerons, or the line bisecting the angle between their chord planes.

In the afternoon I made two runs with Lieutenant Ellyson in the hydroplane, with the apparatus so attached that the silk thread always coincided in direction with the median line, thus showing that the ailerons met the onrushing air at equal angles of incidence, one positive, the other
875 negative. This adjustment was made by moving the foot of the king-post backward to a new socket so placed as to give the necessary change of angle to the two attached ailerons.

During both runs away from shore and towards shore I observed that the silk thread constantly coincided with the median line of the vertical weather vane, which was parallel to the median line of the ailerons themselves, and that the displacements of the spring balance pointer was nothing at all for all indicated velocities ranging from 30 to 35 miles per hour.

876 By Mr. Toulmin: During the giving of the answer to Q3, the witness has had in his lap and hand elaborate memoranda comprising tables of figures, sketches, typewritten sheets and hand-written sheets, to which he has made constant reference Commencing with the sentence "I made two runs with Mr. Curtiss" and ending with "equalling three pounds for both scales," the witness read from one of his typewritten sheets. Also the table given in the answer was copied from one of the memoranda sheets. And the sentence commencing "In

the afternoon" and ending with "the other negative" was copied from one of his memoranda sheets. And also the sentence commencing with "During both runs" and ending with "30 to 35 miles per hour," was read from one of his sheets. The object of this statement is merely to let the Court understand how the deposition is being given. 877

I have here an enlarged photograph which shows the manner of attachment of the spring balances more in detail, and I have numbered the parts which show, to correspond with the other photograph.

878

Counsel for defendants herewith introduces the photograph, and requests that it be marked as Defendants' Exhibit "Zahm Photo #1."

Q6. When were the notes made to which you referred in giving your last answer?

A. The observations were taken about August 8th, 1911, and the notes reduced to form on the following day.

Q7. Did you during those runs with Mr. Curtiss and Lieutenant Ellyson merely note in your mind the angles, speed of the aeroplane and pull of the scales, or did you have material with you to put 879
them down while the runs were being made?

A. The observations were recorded on paper the moment they were taken.

Q8. Please state the length, breadth and depth of curve of each of these ailerons?

A. The length was six feet, the breadth two feet, depth of curve one-half inch at the deepest place.

Q9. You have spoken of the "lever arm" of the cross-arm 4 as being nine inches. How long was the cross-arm from end to end?

A. About twice that length.

880 Q10. In Curtiss Photograph #3 there appear some guy wires. Were the ailerons wired up so that they were substantially immovable, or otherwise?

A. They were wired immovably with respect to one another and to the king-post and were symmetrically trussed to the king-post by fine wires so as to have substantially the same frame resistance, or truss resistance, to the air.

Q11. Was the apparatus symmetrical on each side of the king-post, or not?

A. It was symmetrical to the right and left of the king-post.

881 Q12. You have spoken of the wind-vane 3 as graduated to serve as a protractor. Will you please explain a little more in detail how this wind-vane was constructed and how it was marked off with reference to the attached silk thread, so that the Court can obtain a clear mental picture of it, as the photographs are too small to show this in detail?

A. The wind-vane was a half inch thick plain block measuring nine by twelve inches approximately and hinged to the king-post like a door so as to swing freely about an approximate vertical axis. From a central point near its forward
882 edge radial lines were drawn marking off degrees or multiples of degrees above and below the horizontal line, and at this central point a screw one inch long was inserted having attached to it a fine silk thread which stood out straight in the wind and so indicated its direction on the graduated scale made by the radial lines.

Q13. You have spoken of the "horizontal line." Is this the "median line" to which you referred in your other answers?

A. It is practically parallel to the median line 883
which bisected the angle between the planes and
was drawn practically perpendicular to the king-
post.

Q14. In the table which you have embodied
as part of your answer to Q5, you have given
a list headed "Uprush Angle of Air." In order
to show the Court that the ailerons met the on-
rushing air at unequal angles, will you please
explain how it is that the median line (bisect-
ing the angle made by the chords of the ailerons)
would form an angle (that is tipped downward
from front to rear) when the hydroplane was
moving at the speeds you have mentioned, for 884
in Curtiss photos #1 and #2 the king-post
seems to be set with its top leaning somewhat
forward.

A. The bow of the boat rose farther from the
water than the stern when moving forward stead-
ily over the lake, thus causing the whole appara-
tus to cant forward somewhat from its position
of rest when the boat was not moving, or was
moving slowly; and since the median line of the
ailerons was always perpedicular to the king-
post, it would dip rearwardly below the hori-
zontal when the king-post raked backwards. As
a consequence the silk thread blown back- 885
ward by the practically horizontal rush of air
would make an angle above the downwardly slop-
ing median line.

Adjourned at 4:40 P. M. to 10:30 A. M., Oct. 5th.

886 New York, N. Y., October 5, 1911.

Met pursuant to adjournment, at 10:40 A. M.

Present—Counsel as before.

Q15. You have said in answer to Q5 that in the two afternoon runs with Lieutenant Ellyson the king-post was adjusted so that the silk thread constantly coincided with the median line of the vertical weather vane, which was parallel to the median line of the ailerons themselves, and that the displacement of the spring-balance pointer was nothing at all for all indicated velocities ranging from 30 to 35 miles per hour." Under
887 such conditions what were the angles of incidence of the onrushing air on the two ailerons with respect to the chords of the ailerons?

A. The angles of incidence were numerically equal, one positive, the other negative, the impact being against the lower surface of the downturned aileron, and against the upper surface of the upturned aileron, the angle of impact on each aileron being $10\frac{3}{4}$ degrees.

Take angles— $14\frac{3}{4}$ on down aileron. $6\frac{3}{4}$ on up aileron

Q16. In the same answer you referred to runs made before the ones specified in the preceding question, being runs made with the vertical post raking backward so that the silk thread and
888 consequent air rush was at an angle of four degrees above the median line. What then were the angles of the onrushing air upon the two ailerons?

A. $14\frac{3}{4}$ degrees on the downturned aileron, $6\frac{3}{4}$ degrees on the upturned aileron.

Q17. What change of condition in a flying machine was this change from the condition of Q15 to the condition of Q16 equivalent to?

A. It was equivalent to a canting upward of the aeroplane four degrees above its normal poise

in ordinary flight, thus increasing the angle of in- 889
cidence both of the wings and ailerons by four degrees.

Q18. You have stated in the table in answer to Q5 that under such condition you found that the spring-balances indicated a tension of a certain number of pounds, but as the center of the aileron was $43\frac{1}{2}$ inches from the center of the king-post, and the lever arm 4, to which the spring scales were attached, was only nine inches long, will you please state what was the difference between the turning forces exerted by the two ailerons at their centers?

A. The table shows that at 35 miles an hour the 890
average tension on the scale was $\frac{9.4}{3}$ pounds, which multiplied by $\frac{9}{43.5}$ equals .65 of a pound very nearly, as the difference of turning force on the center of the ailerons due to wind impact.

Q19. If you made any experiment to determine what turning effect this .65 of a pound would produce on a machine like the machine shown in Complainant's Exhibit "Drawing of Defendants' Machine" (of course assuming it to be provided with the usual motor and its accessories), when the machine is not flying through the air but is suspended in still air, and without taking into con-
sideration any factors which would lessen or 891
counteract such turning effect (except the inertia of the machine), please describe it and state what conclusions you found?

By Mr. Toulmin: Objection to these *ex parte* matters is again made or reserved.

A. I suspended such a machine so equipped from the ceiling of a closed shed by means of a one inch manila rope 20 feet long whose axis passed through the center of gravity of the machine, poised as in normal flight and quite clear of the floor; then

892 applied a measured horizontal force perpendicular to the front edge of one aileron and observed the rate of turning about the vertical axis produced by such force on the freely suspended and unrestrained aeroplane. The force so applied was .17 of a pound and the displacement about the vertical axis produced by it was .066 of a degree in one second. From this I conclude that .65 of a pound applied in like manner to the center of one aileron would produce a displacement about the vertical axis of $\frac{65}{17}$x.066 of a degree, or a trifle less than .253 of a degree, in one second.

The turning force of .17 of a pound mentioned
893 above was caused or produced by the natural twist of the suspension rope sustaining the aeroplane and was determined by observing what tension in a horizontal fine thread attached perpendicularly to the middle front edge of the aileron would just balance the torque of the manila rope and hold the aeroplane at rest. The tension in this fine horizontal thread was computed from the observed fact that the other end of the thread displaced laterally $2\frac{1}{8}$ inches a stone weighing $9\frac{3}{4}$ pounds suspended by a string ten feet long.

The rate of turning of the aeroplane rotating freely from rest about its vertical gravity axis
894 due to the twist of the suspension rope, was observed to be 12 inches in eight seconds, from which it follows that the displacement in one second must be 12/64 of an inch, since, as is well known in mechanics, the displacement of a free rigid body urged by a constant torque is proportional to the square of the time of action of such torque; thus the displacement in two seconds is four times the displacement produced in one second, the displacement in three seconds is nine times the displacement produced in one second, etc. Having determined the linear displacement of the aileron

center to be 12/64 of an inch in one second, the 895
angular displacement of the aeroplane was found at once by dividing that quantity by the distance from the aileron center to the vertical gravity axis of the machine, which is 163 inches. This quotient is $\frac{12}{64 \times 163} = \frac{3}{2608}$ radians which equals $\frac{3 \times 57}{2608}$ degrees, or approximately .0655 of a degree, which is substantially the .066 of the preceding paragraph.

The tension in the fine horizontal thread which displaced laterally the suspended stone was computed from the well known fact in mechanics, that for small displacements of such a suspended body the displacing force is to the weight of the body as the length of displacement is to the length of 896
the suspension cord which sustains the body. In the present instance the displacement was $2\frac{1}{8}$ inches, the suspension cord was 120 inches long, and the weight of the stone $9\frac{3}{4}$ pounds; hence the tension in the fine horizontal thread which produced the displacement was $9\frac{3}{4} \times \frac{2\frac{1}{8}}{120} = .17$, which is the .17 mentioned in the first and second paragraphs of the answer. This method of determining the tension in the fine horizontal thread was employed because of its convenience and accuracy, since the weight of the stone and its displacement and the length of the suspension cord could all be accurately measured with the instruments in hand. 897

Adjourned for lunch at 1 P. M. to 2 P. M.

Q20. In order to crystallize the above, please state, as a conclusion from your experiments, what amount of turning about its vertical axis, would, theoretically, be given in one second to a machine (like Complainant's Exhibit "Drawing of Defendants' Machine," when provided with a motor) if the ailerons used were those shown in Curtiss photograph #1, #2 and #3 mounted on the king-post 6 and described by you, when

898 the machine is flying at 35 miles an hour at an angle of incidence four degrees greater than the normal (or meeting a wind having a resultant angle of four degrees upward), but without taking into consideration any factor (excepting the inertia of the machine) which would oppose such turning.

A. The displacement about the vertical axis should be .253 of a degree in one second, if the difference of turning force on the ailerons when mounted in a given aspect and angle of incidence in the aeroplane is the same as when mounted as described in the foregoing experiment on the
899 lake, and if only the resisting inertia of the aeroplane be taken into account, neglecting all other resistances due, for example, to the action of the air against the wings, framing, horizontal rudders, vertical fins, fixed vertical rudder, etc., and the possible wedging effect of the air rushing between the upturned aileron and the wing surface above it.

Q21. Leaving out, for the moment, the other factors opposing such turning, except the "wedging effect of the air" which you have mentioned, please state what you meant by it and what its effect would be?

900 A. Complainant's Exhibit "Drawing of Defendants' Machine" shows the upper wing surface A longer than the lower ones A′, so that when the ailerons are set at the assumed angles, the air apparently flows less freely past the upturned aileron than it does past the other aileron. Even if the upper surface did not protrude laterally beyond the lower one, still the curvature is such that the air would apparently flow less freely between the upturned aileron and the upper surface than it would between the downturned aileron and the lower surface. Thus there would be more crowding or obstruction in the

flow of air past the upturned aileron, and consequently more forward resistance. 901

Q22. Mr. Curtiss has testified that that exhibit drawing does not show the true curve of the upper and lower surfaces, but that they are more curved, in fact with the deepest part of the curve toward the front. He has also testified that the normal plane in which the ailerons are set coincided, as nearly as possible, with the normal air rush. Under that assumption, and assuming that the machine were flying so that the air rush meets the chord of the main supporting surfaces at a positive angle of incidence, would, or would not, the rear edge of aileron B 902 when turned up be nearer to the chord of the upper surface than the rear edge of aileron B′ would be to the chord of the lower surface?

A. The upturned rear edge of aileron B would be nearer the upper surface than the downturned rear edge of aileron B′ would be to the lower surface, providing that the forward edges or pivots of the ailerons are placed midway between the forward edges of the sustaining surfaces A and A′ as shown in Complainant's Exhibit "Drawing of Defendants' Machine."

Q23. Will you please explain how the air striking the convex surface of the upturned 903 aileron would be deflected, and what effect its striking the concave surface of the upper surface A would tend to produce?

A. The tendency would be to increase the pressure on top of the aileron and underneath the surface above it, thus increasing the forward resistance of both, that is say, their head resistance or turning force about the vertical axis.

Q24. Would the head resistance caused by the wedging effect of the air on the side on which the

904 aileron is turned down, be the same as that caused by the wedging effect of the air on the side on which the aileron is turned up, and, if not, why not, if you see any explanation of it?

A. The exhibit drawing shows that the passageway for the air between the upturned aileron and the surface above it is smaller than the passageway between the down-turned aileron and the surface below it, in all cases when the ailerons are adjusted at equal angles above and below their median line, hence the wedging effect must be greater on the side having the upturned aileron.

Q25. In the machine shown in Complainant's
905 Exhibit "Drawing of Defendants' Machine," would the wedging effect have the same lateral extent on the side that the aileron is turned down as on the side on which the aileron is turned up?

A. There would be practically no wedging effect on that part of the downturned aileron which protrudes laterally beyond the end of the lower sustaining surface, whereas the wedging effect above the upturned aileron would extend practically over its entire area, since it is shown to protrude laterally about the same distance as the upper sustaining surface.

Q26. Would or would not this wedging effect
906 have a tendency to counteract any turning tendency theoretically given to the machine by the downturned aileron?

A. Obviously it would.

Q27. Now, turning to some of the other factors which you have mentioned as tending to counteract or lessen any turning tendency given to the machine because of the drift on the ailerons themselves, and which you have mentioned in answer to Q20, (and disregarding for the present any counteracting effect which might be offered by the rear vertical rudder even though it were not moved

from its central position), would or would not the 907
action of the air in flight against the wings, framing, etc., tend to counteract any possible tendency to turn given to the machine when the ailerons were used?

A. It would; for excluding from consideration for the present the action of the vertical rudder, the remaining parts of the aeroplane may be divided into two classes, those which have in some measure the effect of a fixed vertical rudder and those which have not. The latter surfaces offer a resistance to turning about the vertical axis when the machine is in flight, owing to the fact that such turning
increases the resistance on all those parts of the 908
machine which are gaining speed, thereby also increasing the torque opposing the turning. Among the surfaces having a rudder-like effect may be mentioned the vertical posts and the bamboo rods fixed to the rear of the machine. These have a resistance to turning, not only because of increased velocity but also because any slight displacement about the vertical axis causes the air to impinge laterally upon them, thereby producing an unbalanced and corrective pressure tending to counteract the assumed resultant torque of the ailerons about the vertical axis.

Q28. You have, in your answer to Q20, included 909
the fixed vertical rudder as one of the factors opposing the theoretical tendency of the ailerons alone to turn the machine the minute amount you mentioned. Assuming that the rear vertical rudder is not turned to either side but is held in its neutral position in the longitudinal axis of the machine, please state what effect it would have?

A. To answer this question will require a computation, which I should be pleased to begin at once but which will require more time than the

910 few minutes remaining at this session. If you wish I will have it ready by tomorrow morning.

Adjourned at 4.20 P. M. to Ocotber 6th, at 10.30 A. M.

New York, N. Y., October 6, 1911.

Met pursuant to adjournment, at 10.40.

Present—Counsel as before.

(Answer continued.)

Assuming the vertical rudder to remain fixed
911 in the longitudinal axis of the machine, and hence to spin about the vertical axis the same amount as the machine itself due to the resultant torque of the ailerons above specified, I have computed the normal or side pressure on the rudder at the assumed displacement of .253 of a degree to the instantaneous direction of the course or air rush. The rudder has been assumed to be 25 inches long, 36 inches high (as stated by Mr. Curtiss), and 14 feet from its center of pressure to the vertical axis of rotation of the machine, this 14 feet being substantially the distance from the center of the rudder to the center
912 of the line joining the mid-points of the sustaining surfaces, as given by Mr. Curtiss. The pressure per square foot on the rudder was found by multiplying the square of the velocity in miles per hour by the factor .003, then by the factor in Chanute's Table (page 4, Progress in Flying Machines) $\frac{0.035}{4}$ for determining the proportionate resistance at the assumed angle of .253°. Multiplying this pressure per square foot by the area of the rudder, $\frac{36x25}{144}$ feet, gives the total normal or lateral pressure against the rudder, assumed as moving without rota-

tion against the air at an angle of .253 of a 913
degree. Multiplying the lateral pressure against the rudder by 14, the assumed arm of the rudder in feet, gives the rudder moment, or resistant torque about the vertical axis. The entire computation is indicated as follows:

At .253° rudder torque $= \frac{35 \times 35 \times .003 \times 36 \times 25 \times .035 \times 14}{144 \times 4}$ lb. feet $= 2.8$ lb. feet.

If the lateral motion of the rudder due to the spinning of the aeroplane about its vertical axis be taken into account, the angle of incidence of the air against the rudder will be considerably
increased. Thus if the turning torque be con- 914
stant and the angular displacement of the rudder and machine be .253 of a degree in one second, their angular velocity at the end of one second must be twice that amount, or .506 of a degree per second, which means that the rudder has a lateral linear velocity of substantially 1.5 inches per second. This lateral velocity combined with the forward velocity of 35 miles per hour gives an increase in the angle of incidence of the air against the rudder of substantially .15 of a degree, which added to the .253 of a degree displacement already as-
sumed, makes the actual angle of impact of the 915
air against the rudder spinning with the machine substantially .4 of a degree. The actual resistant rudder torque therefore must be $\frac{2.8 \times .4}{.253} =$ 4 lb. feet, instead of 2.8 lb. feet. At the same instant the assumed constant aileron torque about the vertical axis of the machine is .65x13 7/12=8.83 lb. feet, which is resisted by the rudder torque of 4 lb. feet. Under the same constant aileron torque the angular displacement of the machine in one second and a half would be $2\frac{1}{4}$ times the amount of the displacement

916 in one second, whereupon the resistant rudder torque would be about 7.4 lb. feet, estimated in a manner similar to the foregoing; and before the end of two seconds the resistant rudder torque would exceed the disturbing torque of 8.83 lb. feet as above computed. This would be the effect of the rudder unaided by the resistance of the other parts of the aeroplane, i. e., surfaces and framing, or by the wedging effect of the air between the upturned aileron and the surface above it.

Q29. Then, in order to crystallize the foregoing, please state as a conclusion from your ex-
917 periments and computations (and omitting the influence of the wedging effect of the air on the ailerons, and the resistance of the framing—all of which you have stated would contribute to resist the turning of the machine) how soon would the rear vertical rudder (even though not moved from its central position) stop the acceleration of the machine theoretically caused by the continued use of such ailerons, even though the machine is at an angle of incidence four degrees greater than the normal?

A. In a period of time between 1 1/2 and 2
918 seconds, or more nearly, a trifle under 1.7 seconds, assuming that the ailerons exert their maximum disturbing torque for this entire time.

Q30. How far would the machine have rotated up to the time when the resistance of the unaided rudder balances the assumed disturbing torque caused by the ailerons?

A. Assuming the rate of displacement about the vertical axis to remain constantly .253 of a degree per second, the displacement in 1.7 seconds would be .253 of a degree multiplied by the square of 1.7. This product is .253x 2.89=.73

of a degree. In reality the displacement would be much less than this amount because the acceleration due to the assumed constant disturbing torque cannot itself be constant since the aeroplane is not rotating freely, but is rotating against the resisting torque of the rudder, which at the end of 1.7 seconds reduces the acceleration to nothing. 919

Adjourned at 1 P. M. to 2 P. M.

Resumed at 2 P. M.

Q31. You have stated that the rudder would stop the acceleration of the machine in a trifle under 1.7 seconds. Would the machine stop at this .73 of a degree, or what would occur? 920

A. In answer to Q29 I meant to say that, even if the machine rotated as a free rigid body urged by the disturbing aileron torque constantly at its maximum, the displacement about the vertical axis would, at the end of 1.7 seconds or a trifle under, be such that the pressure of the air against the fixed vertical rudder would balance the disturbing torque of the ailerons; but owing to the continuous resistance of the rudder during such displacement, the actual time would be slightly above 1.7 seconds. 921
Also in answer to Q30 I find by computing the air resistance on the rudder by aid of Chanute's table previously employed, that the angle of impact of the air against the rudder must be approximately .78 of a degree in order that the rudder torque about the vertical axis may balance the assumed maximum resistant aileron torque. This angle diminished by .15 of a degree, the increment in the angle of incidence due to the lateral motion of the rudder as computed in my answer to Q28, leaves .63 of a degree as the angle between the longitudi-

922 nal axis of the machine and the course of flight, at which the pressure on the fixed vertical rudder will just balance the assumed disturbing torque of the ailerons. This angle is a trifle less than the .73 of a degree computed by the other method.

Now, answering Q31 directly, I may say that the machine would not stop precisely when the pressure on the rudder exactly balanced the disturbing torque of the ailerons, but owing to its acquired angular momentum, it would swing slightly past the angle of .63 or .73 of a degree, then be promptly checked by the great preponderance of the rudder torque over the aileron torque,
923 and caused to return to the angle of balance of .63 or .73 of a degree, or slightly below.

Q32. Then if there were no influence to turn the machine about its vertical axis except that produced by the use of the ailerons,—if the ailerons were continued in use thereafter, would the machine rotate any further?

A. The machine would cease to rotate further, but continue on its course skidding at the slight angle of .63 or .73 of a degree.

Q33. What would happen if the ailerons were then brought back to their normal position. Would the machine continue skidding at this minute angle,
924 or what would happen?

A. The resisting torque of the rudder would be unopposed except by the angular inertia of the machine about the vertical axis, and consequently would tend to turn the machine so as to diminish the skidding angle indefinitely, ultimately eliminating it altogether.

Q34. None of your answers today have taken into account the resistance of the framing or the wedging effect of the air due to the upturned aileron, have they?

A. No. 925

Q35. If such factors were taken into account, would the theoretical minute turning you have computed be increased or diminished?

A. As far as influenced by the resistant parts of the machine other than the wedging, the turning would be diminished. The wedging of the air between the upturned aileron and the surface above would diminish the turning about the vertical axis, because it exerts a torque opposite in direction to the assumed resultant or disturbing torque of the ailerons.

Q36. In the questions today we have assumed that the machine was flying at an angle of inci- 926
dence four degrees more than the normal angle of incidence. Roughly, how much additional weight would have to be put on the machine flying at the same speed to give it this increase of four degrees in the angle of incidence?

A. Referring to Lilienthal's table (page 178 Aeronautical Annual, 1897, I should judge the additional weight should equal $\frac{792-650}{650}$ of the whole original weight of the machine and its operator. This additional weight would be about 140 pounds. The same result may be obtained by use of the more familiar form of Lilienthal's table on page 290 of Moedebeck's Pocket Book of Aero- 927
nautics. The result just given assumes that the normal angle of incidence of the aeroplane before receiving the additional load of 140 pounds was five degrees.

Q37. Would your answers given today up to the last one apply equally as well to a condition where the machine flying through the air meets an upward wind such as to give an increased angle of incidence of four degrees (without at present regarding the upward yielding of the aeroplane due to it which would immediately decrease this angle)?

928 A. Yes, substantially so.

Q38. When the machine flying through the air meets an upward current of wind, what happens; does the machine continue on in the same line of flight, or does it yield, and what effect relative to the apparent angle of this new current is produced?

A. The effect of the up-current is to increase the angle of incidence of the air against the sustaining surfaces by an amount which can be readily determined by graphically adding the velocity of the aeroplane to the reversed upward component of velocity of the air, thus forming a velocity triangle in which the angle between the hypothenuse and
929 the side representing the velocity of the aeroplane, assumed to be horizontal, is the increment of the angle of incidence. Thus if the machine has a horizontal velocity of 35 miles per hour through the air and the upward component of the wind velocity be five miles per hour, the increment of the angle of incidence is an angle whose tangent is 5/35=.1428, or slightly over eight degrees. In general the faster the speed of the aeroplane, the less the increment in the angle of incidence due to any given upward component of the velocity of the air.

Adjourned at 4.30 P. M. to Oct. 7th, at 10.30 A.
930 M.

New York, N. Y., October 7, 1911.

Met pursuant to adjournment, at 10.30 A. M.

Present—Counsel as before.

A. (Continued.) It should be observed also that the hypothenuse of the velocity triangle just mentioned indicates the speed, as well as the direction of the onrushing air, showing that any vertical

component of air velocity must increase the relative velocity of the air and the machine, or in 931
other words the velocity of impact of the air against the sustaining surfaces. Since, therefore, both the velocity and angle of impact are increased, the lift of the machine must be increased due to this twofold cause, and thus imparts an upward acceleration until the normal direction of air rush is restored.

Q39. As an instance of the foregoing, assume that the machine is flying in a horizontal direction at 40 miles an hour and runs into an upward wind moving at 10 miles an hour along a slope of 20
degrees to the horizontal course of the machine. 932
What would be the increase of the angle of incidence upon the aeroplane at the instant of meeting this upward current?

A. The increment of the angle of incidence would be slightly over $4\frac{3}{4}$ degrees. This is a familiar problem in Elementary Mechanics solved by use of the velocity triangle mentioned in my answer to Q38. The vertical component of the assumed ten mile wind is ten times the natural sine of 20 degrees, or 10 x .34202=3.42. This vertical component 3.42 combined with the horizontal speed through the air, 40 miles per hour, of the aeroplane, gives a velocity triangle in which the tan- 933
gent of the angle between the hypothenuse and the longer side is $\frac{3.42}{40}$=.0855, and this is the natural tangent of an angle slightly greater than $4\frac{3}{4}$ degrees, as stated in the first sentence of this answer.

Q40. As the aeroplane is carried upwardly by this upward component of the new current, what would happen to the angle of $4\frac{3}{4}$ degrees. Would it remain the same or decrease?

A. It would instantly begin to decrease, and go on decreasing until the normal rush of air was

934 restored, and the increment of $4\frac{3}{4}$ degrees was entirely eliminated.

Q41. In the same assumption of Q39, how fast would the aeroplane (assumed to weigh 650 pounds as defendants' machine does) be carried upwardly?

A. It would begin to be carried upwardly with an acceleration equal in feet per second to 32 times the increment of lift, divided by the whole weight lifted. From Lilienthal's table previously used, the increment of lift is found to be $\frac{.804 - .650}{.650} \times 650 = 154$ pounds, assuming the angle of incidence to increase fron its normal value five degrees to the increased value $9\frac{3}{4}$ degrees due to the $4\frac{3}{4}$ de-
935 gree increment above computed. Dividing this increment of lift by the whole weight of the machine and mulitplying by 32 gives $\frac{154 \times 32}{650} = 7.58$ feet per second, per second, as the vertical acceleration of the machine at the instant the increased lift begins. It may be noted that 7.58 feet per second is slightly more than five miles per hour as compared with the 3.42 miles per hour vertical component of the assumed wind velocity.

Q42. I show you here Defendants' Exhibit "Wright Article on Angle of Incidence," which Mr. Wilbur Wright has said that he wrote. Does what he says on the first page of that article corroborate
936 you or not in your answers given today?

A. It corroborates my method of finding the angle of incidence and relative velocity, since both the problems solved by Mr. Wright and those solved by myself are special examples of the well known method used in Elementary Kinematics for finding the relative motion of one body with respect to another.

Q43. You have said that the vertical acceleration of the machine at the instant it struck this new wind would be 7.58 feet per second. Roughly, about how soon would the $4\frac{3}{4}$ degrees resultant increase of angle of incidence be reduced to substantially nothing?

A. As soon as the vertical component of 937
velocity of the aeroplane became 3.42 miles per hour, or five feet per second, very approximately, which is the vertical component of the assumed wind velocity. If the vertical acceleration of 7.58 feet per second were constant, the vertical component of the velocity of the aeroplane would become five feet per second in $\frac{5}{7.58}$ of a second, or roughly 2/3 of a second, but as the increased lift on the upwardly yielding aeroplane cannot remain constant with the assumed constant uptrending wind, rather more than 2/3 of a second would be required to eliminate the 4 3/4 de-
gree increment of the angle of incidence, and 938
restore the normal direction of air rush. Roughly speaking, I should say the time required to minimize the increment of 4 3/4 degrees to a substantially negligible value would be in the neighborhood of one second.

Q44. Then, whether an aeroplane is flying horizontally, upgrade, or downgrade, and strikes a cross current of wind blowing obliquely up, down or sidewise, is the machine carried along by it and the apparent resultant angle of the new wind progressively modified so as to restore the rush of air to its original direction with respect
to the machine, owing to the yielding of the 939
machine?

A. Yes.

Adjourned at 1 P. M. to Monday, Oct. 9, at 10.30 A. M.

New York, N. Y., Oct. 9, 1911.

Met pursuant to adjournment, at 10.40 A. M.

Present—Counsel as before.

Q45. As an example of Q44, suppose that an aeroplane is to fly along a horizontal line due

940 north in a wind blowing steadily due east and upward along a plane slope whose base runs due north, what must be the poise of the machine to ensure a steady and normal air rush?

A. The aeroplane must point westward of its horizontal northerly course enough to neutralize the easterly component of the wind speed and make the air rush due fore and aft; the machine must dip sufficiently to neutralize the upward component of the wind's motion and thus maintain the natural angle of incidence. So poised, the aeroplane can fly with the same steadiness as if navigating calm air.

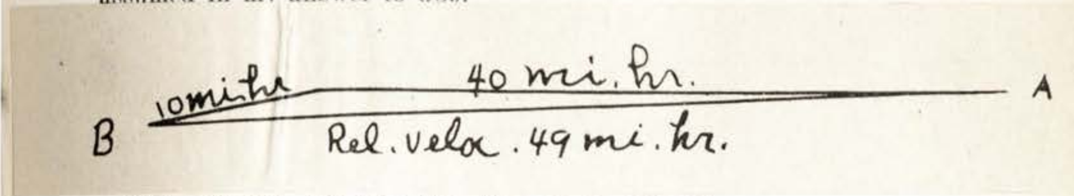
941 Q46. Would it be necessary to use the ailerons to maintain this poise continuously, after having once obtained it?

A. No.

Q47. In your answer to Q39 you considered only the vertical component of the wind. Please include both the horizontal and vertical components in your estimate of the resulting relative velocity and direction of the air rush, and state what result you obtain.

A. Applying the same general method gives an oblique angled velocity triangle (as shown be-
942 low) whose third side shows that the relative velocity in this case is 49 miles an hour and the increment of the angle if incidence is four degrees, making the entire angle of incidence nine degrees. The increment of lift on the aeroplane due to both the increased relative velocity and angle of incidence is 213 pounds, as shown by the use of Lilienthal's table, before employed, and the vertical acceleration is 10.4 feet per second per second. If this acceleration remained constant, the machine would acquire the vertical velocity component of the wind, or five feet per second,

in $\frac{5}{10.4}$ of a second, or substantially one-half 943
second instead of two-thirds of a second as found in the solution for the more restricted conditions, assumed in my answer to Q39.



The velocity triangle for this more general case is here presented, with the remark that the relative velocity of any moving point A with respect to any Point B moving in the same 944
plane is found by graphically adding the velocity of A to the reversed velocity of B, both taken with respect to any point B moving in the same thus forming a velocity triangle whose third side represents the relative velocity in both magnitude and direction.

Q48. Is your method of finding, in this more general problem, the relative velocity of the air with respect to the machine, also corroborated by the article mentioned in Q42?

A. Yes; the constructions referred to in that article are made by a method similar and equivalent to the one employed by me in the foregoing 945
answer for finding the relative velocity by use of the familiar velocity triangle of elementary mechanics.

Q49. From your computations in answer to Q46, please state how soon the aeroplane would yield to the increased lift sufficiently to eliminate the increment of four degrees in the angle of incidence.

A. In less than one second. The average surplus lift for all angles of incidence from nine degrees at the beginning of the acceleration, to five degrees at the end is about half the surplus

946 lift at nine degrees, as may be seen by inspecting Lilienthal's table previously used; hence the average vertical acceleration must be about $\frac{10.4}{2}=5.2$ feet per second, or half the maximum acceleration. Hence the time required to give the machine a vertical component of velocity equal to the wind's vertical component of five feet per second must be $\frac{5}{5.2}$ or a trifle under one second, assuming the relative velocity of the air rush to remain sensibly constant for that short period.

Q50. To summarize results, then, your answers so far indicate that the aeroplane, when
947 subjected to the extreme torques about the vertical axis assumed in our examples, will have its turning acceleration nullified by the fixed or unmoved vertical rudder, before the machine has turned 3/4 of a degree, and the machine will yield in one second or less to the extreme and sudden uprush of wind assumed. Is that correct?

A. Yes.

Q51. Assuming that defendants' machine, is flying at 40 miles per hour and has a lateral tilt of ten degrees, that the disturbing force has ceased, and that the operator moves the ailerons so that they form an angle of 21½ degrees
948 between them (as assumed in a former example), how long must they be held there to give the machine a righting impetus sufficient to restore its lateral equilibrium?

A. Assuming as approximately true that the moment of inertia about the longitudinal axis of the aeroplane is the same as that about the vertical axis, the data given in my answer to Q19 may be employed to compute the angular acceleration about the longitudinal axis. It was there shown that a force of .65 of a pound applied to the aileron center would produce an angular acceleration about the vertical axis

amounting to .506 of a degree per second per 949
second. Now for the conditions given in your question, the positive lift on one aileron and the negative lift on the other would be 20.4 pounds, as computed by use of Chanute's table before employed. The angular acceleration therefore produced by each aileron must be $\frac{20.4x.506}{.65}$ degrees per second per second, or 15.88 degrees; hence for both ailerons combined the acceleration must be 31.76 degrees per second per second. If the aeroplane subject to this acceleration rotated as a free rigid body without atmospheric resistance, the time of righting completely would be approximately .8 of a second. 950
Of course in actual flying the righting effect of the ailerons can be discontinued before the machine is restored to its natural level balance, because the acquired angular momentum will continue the righting motion for some time after the righting torque has ceased.

Taking account of both the inertia of the machine and the resistance of the air, I find that in a period of time slightly over 1/4 of a second, the torque of the ailerons about the longitudinal axis would generate and steadily maintain a righting angular velocity of 8 to 10 degrees per 951
second. The machine should therefore receive sufficient righting displacement and impetus to restore equilibrium after the ailerons had been used one second or less.

Q52. Suppose the aeroplane were tilted considerably more than ten degrees and at the same time subject to the increase of four dgrees in the angle of incidence found in your answer to Q47, how long should the ailerons be used to furnish an angular impetus sufficient to restore equilibrium, and what disturbance about the vertical axis would theoretically ensue?

952 A. The ailerons could be used more than one second, but as shown in my answer to Q47, the disturbing torque about the vertical axis due to unequal aileron drift would cease in about 1/2 of a second, owing to the upward yield of the aeroplane and the consequent elimination of the abnormal four-degree increment in the angle of incidence.

Adjourned at 1 P. M. to 2 P. M.

Resumed at 2 P. M.

953 Q53. Your answers show that, even with the machine flying at a four degree increase over the normal in the angle of incidence and tilted to ten degrees laterally, the ailerons would be used for less than one second and would theoretically turn the machine .253 of a degree in one second, and that the pressure of the wind on the unmoved vertical rudder would restore the machine to a course parallel to its original direction. How much would the machine be displaced laterally?

A. The angular momentum acquired by the machine during the one second action of the aileron torque would carry the machine through an entire
954 displacement about the vertical axis amounting to rather less than twice .253 of a degree, as may be seen by equating the work done by the torque to the work consumed by the resistance of the vertical rudder; and the time from the beginning of the disturbance until the vertical rudder restored the original orientation of the machine would be between three and four seconds. During this period the machine would be pushed sidewise by the continuous rudder pressure whose average value for the entire displacement is found from Chanute's table to be .385 of a pound, aided by the propeller torque of 160 pounds, whose average lateral com-

ponent for the entire time may be estimated 955
160 x Sin .253 degress—160 x .00436=.6976 Lb. Thus the combined lateral force of the rudder and propeller, aggregating about 1.07 pound, would give an average lateral acceleration of $\frac{1.07 \times 32}{650}$ feet per second, per second or about 1/20 foot per second. The entire displacement therefore would be $1/2 \times 1/20 \times 3^2 = 9/40$ of a foot in three seconds, or 16/40 feet in four seconds. In other words, the lateral displacement would be 2.7 inches in three seconds, during which the machine would travel roughly 150 feet forward, and 4.8 inches in four seconds during which the machine would advance
200 feet. The machine would then pursue its 956
course with practically its original orientation at the instant the disturbance began.

Adjourned at 4.30 P. M. to Oct. 10, at 10.30 A. M.

New York, N. Y., October 11, 1911,
11.20 A. M.

Present—Counsel as before.

No testimony taken yesterday while Counsel for both sides were in Buffalo on the motion, as the witness spent the time going
over his testimony heretofore given. 957

(The witness continuing his answer.)

By vertical axis I mean a fixed line in the machine perpendicular to the transverse and longitudinal axes of the aeroplane, and passing through the center of mass.

Q54. Would such minute displacement be detectable by the aviator in ordinary flight?

A. No.

Q55. What practical effect on the length of the course and time of flight over the course would be

958 produced by such minute and undetectable theoretical lateral displacement of the machine of 4.8 inches in 200 feet, even assuming that the up and down wind puffs recurred at frequent intervals continuously during a flight of several miles through the air?

A. The effect would be similar in practical effect and appearance to that produced by the Captain of a ship walking to and fro across the bridge of his vessel, thereby producing an alternating torque about the vertical axis of the ship, owing to the wind resistance against his body, and thus causing the vessel theoretically to follow a wavy course of
959 slightly increased length and time of passage.

If the aeroplane be displaced laterally 4.8 inches in a distance of 200 feet, the increased length of path is very closely .0048 of an inch, or two parts in one million, and therefore also the time of transit is increased by two millionths of itself. Hence if such lateral displacements take place to and fro every four seconds at regular intervals during a flight of 100 miles, the length of the course would be increased by one inch and the time of transit would be increased by .002 of a second. In my special investigations with instruments designed to show the variations in the direction of
960 the wind referred to in my affidavit of November 22, 1909, given for the complainant, I found that the wind blows alternately up and down, so that in any prolonged voyage, or any considerable voyage, the up and down puffs of wind are sensibly equal in duration and magnitude, on the average.

Recess for Lunch.

Resumed After Lunch.

My observations also show, as do likewise the wind records of the United States Weather Bureau, that the air is practically always moving with a velocity sufficient to displace the machine laterally many times 4.8 inches in four seconds. If the wind have the very low velocity of four miles per hour squarely across the path of the aeroplane, the machine if not steered, will drift laterally nearly two feet in four seconds, or while advancing 200 feet, and if the wind speed be 12 miles per hour across the path, the machine will drift laterally nearly six feet while advancing 200 feet, and in a quartering wind blowing 12 miles an hour and at 45 degrees across the course, the lateral component of drift would be four feet in the same space of time, or 48 inches as compared with the 4.8 inches of lateral drift due to the above-assumed torque of the ailerons about the vertical axis. 961 962

From what precedes it is obvious that the vertical rudder need not be used to prevent or correct the minute lateral displacements indicated by theory but rather to prevent or correct the lateral displacements caused by other agencies of a substantial nature.

Q56. From your experiments and calculations do you consider that, under any condition of the air encountered in practical flights with defendant's machine, the ailerons would cause a turning or swerving which would require the movement of the vertical rudder to preserve or restore the lateral equilibrium of the machine? 963

A. No.

Q57. If you, on August 7th and 8th, 1911, observed any flights by Mr. Curtiss in a machine similar to that shown in Defendants' Exhibit "Post Photograph #1," please describe them and state whether or not any turning or swerving was detectable when the ailerons were used?

964 A. I observed Mr. Curtiss make several
flights with such machine in order to determine
whether any perceptible displacement about the
vertical axis occurred when the ailerons were
worked. In one series of experiments the usual
curved ailerons had their control wires so affixed
to the yoke at the operator's back that their
median plane inclined five degrees below the line
of flight and in another series five degrees above
the line of flight, so as in each case to make the
angle of incidence five degrees greater for one
aileron than for its mate. Several flights across
the field were made with each such adjustment
965 of the neutral plane without working the vertical rudder, and when the ailerons were worked
I could observe no material turning of the aeroplane about its vertical axis, though I stood
directly in the line of flight, and sighted along
the bamboo framework. The course of flight
was sometimes very straight and at other times
somewhat curved when the aeroplane seemed to
drift in the direction of the slight wind blowing
at the time the flight was in progress. In these
experiments no attempt was made to steer the
machine except at the beginning and end of the
966 flight, and in general the machine appeared to
fly very level except during the instant when the
ailerons were worked. Other flights were made
with like results when the median plane of the
ailerons was in the line of flight.

Q58. In your last answer you said that you could "observe no material turning of the aeroplane about its vertical axis." If you observed any turning at all, please state how it compared with the theoretical turning which you have computed from your experiments and referred to in your previous testimony.

A. In sighting along the thirty-foot bamboo 967
framework in the line of flight, especially when
illuminated by the evening sunshine, there seemed
to be a lateral displacement of perhaps an inch
or less of the extreme ends of the framework
with reference to one another, but whether this
was due directly to the disturbing torque ex-
erted by the ailerons about the vertical axis or
whether it was in part due to some other cause
I could not testify with rigorous certainty, but
whatever the cause, a lateral displacement of the
extremities of the bamboo framework with ref-
erence to one another through a distance of
one inch would represent a displacement about 968
the vertical axis of approximately 1/6 of a de-
gree.

Defendants' counsel introduces herewith a photograph which is requested to be marked as Defendants' Exhibit "Zahm Photo #2."

Q59. If you made any flights in the hydro-
machine like Defendants' Exhibit "Zahm Photo
#2," please describe them and state if the aile-
rons which are hung to the rear posts were used
in balancing, and whether or not there was 969
any turning or swerving of the machine when
said ailerons were moved, which you could de-
tect.

A. On the evening of the first Sunday in August, 1911, I made a flight with Mr. Curtiss in the above-described hydro-aeroplane with the aileron cords firmly attached to the yoke, and when we were well in the air I could observe no turning about the vertical axis when the ailerons were worked, and I was careful also to observe that the steering wheel was not worked

970 at all and that the vertical rudder remained fixed in the longitudinal axis of the machine.

Q60. In your affidavit of Feb. 22, 1910, on the motion for preliminary injunction, you closed with the words: "From my theoretical and experimental knowledge of aviation I am of the opinion that there is nothing scientifically incredible in the statement that in defendants' machine the balancing surfaces do not cause any deflection of the machine around a vertical axis which is perceptible to the operator under the conditions of practical flight. My computations show that any such deviation would be very minute
971 even under exceptional conditions. I conclude, therefore, that such deviations are negligible, and I believe that Mr. Curtiss' statement that he does not turn his rudder on account of any effect produced by the balancing surfaces, is true."

Have or have not the experiments, observed flights, and calculations made by you, served to confirm or change you in your opinion above quoted?

By Mr. Toulmin: Objected to as incompetent, as complainants cannot be bound by an *ex parte* statement by the witness.

972 A. They confirm me in that opinion.

Adjourned at 4.45 P. M. to Oct. 12, at 10.30 A. M.

New York, N. Y., Oct. 12, 1911,
11.20 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

Q61. In your answers to Q57 and 58 you stated that in the flights made by Mr. Curtiss with

the machine like "Post Photograph #1" but having 973
curved ailerons, there seemed to be a slight turning of perhaps 1/6 of a degree or less at some times. Was such seeming minute rotation about the vertical axis invariably initiated at the instant of working the ailerons, was it always in the direction indicated by your theory and conputations, and are you satisfied that it was not caused by some other agency than the theoretically indicated torque of the ailerons?

A. Such seeming minute rotation about the vertical axis was observed to be taking place during the brief instant when the ailerons were worked, but as stated in my answer to Q58 I cannot testify 974
with rigorous certainty whether this turning was due directly to the disturbing torque exerted by the ailerons about the vertical axis, or whether it was in part due to some other cause. It was not invariably initiated at the instant of working the ailerons, and I did not observe whether or not such minute turning was always in the direction indicated by theory.

Q62. You have shown that even under exceptional conditions in defendants' machine (such an increase of angle of incidence of four degrees) the aileron torque about the vertical axis would be negligible and undetectable by the aviator and 975
that it would be checked without moving the rear rudder. What have you to say in regard to the glider of the patent in suit under analogous conditions?

A. The glider of the patent in suit as shown in the drawings and so far as clearly disclosed in the verbal description provides only for the simultaneous and constrained working of the rudder and warping mechanism of the wings. Such a machine while physically capable of being navigated in both rectilinear and curvilinear flight when handled

976 with due skill and precaution in favorable atmos-
pheric conditions, would be dangerous and inopera-
tive for purposes of practical flight.

The glider of the patent in suit, as the complain-
ants would have the verbal description in the text
of the patent construed, that is with the simulta-
neous operation of the two marginal tips and the
cooperation of the vertical rudder whether simul-
taneously moved or not, is a practical aeroplane
when, and only when, the vertical rudder is mov-
able independently of the warping of the wings. It
may be possible so to design the patented machine
as to avoid serious turning about the vertical axis
977 when only the wings are worked if something is
added which is not disclosed in the patent, but the
complainants have not disclosed how this can be
done, and have themselves affirmed the necessity
of cooperatively working both the rudder and wing
tips. With this academical reservation I testify
again, as substantially shown in my affidavit of
February 22, 1910, that the machine of the patent
in suit is not practically controllable without the
cooperative working of the vertical rudder and
the wing tips. In this respect it is mechanically
and functionally different from defendants' areo-
plane whose ailerons were purposely and ade-
978 quately designed to obviate the necessity of turning
the vertical rudder either cooperatively or con-
junctively with the lateral stabilizing surfaces. In
the machine of the patent in suit it is necessary to
work the vertical rudder to counteract the large
vertical torque of the wings when warped; in de-
fendants' machine it is impossible for the pilot to
perceive the effect of such torque, if any exist, or
to turn the rudder so slightly as to provide for it
without over-correcting and thus introducing a
larger disturbance.

I further testify that the independently coopera- 979
tive working of the vertical rudder and the wing
tips seems to me not to be disclosed by either the
drawing or wording of the patent in suit. On the
contrary, their constrained working is clearly
shown in the drawing and emphasized in the verbal
description and theoretical explanation of the ma-
chine. There is nothing in the entire patent, either
in the diagrams, the preamble or in the claims to
disclose the absolute essentiality of a vertical rud-
der independently and cooperatively workable with
the warping wings, nor is there in the entire patent
anything to indicate that the inventors understood
the indispensability of such unconstrained coopera- 980
tive workability; on the contrary, the whole tenor
and description of the patent is to disclose and
theoretically advocate a controlling mechanism
which is dangerous and impractable for use in
ordinary practical flight even in ordinary weather.

The dangerous and impracticable nature of the
aeroplane of the patent in suit, as clearly disclosed
by word and diagram in the patent, may be broadly
predicated from the fact that only a single mechan-
ical movement is provided for exerting both equil-
ibrative and steering torques about two rectangular
axes of the machine, the longitudinal and the verti-
cal, in all the multitudinous and varying conditions 981
of flight, such as enumerated by complainants on
page 226 of their affidavit of November 27th, 1909,
by means of stabilizing surfaces whose torques op-
pose each other according to different laws of
variation, with inadequate or with no provision
for equalizing the resultant effect of such opposing
torques.

Recess at 2 o'clock for Lunch.

982 As is well known, the impactual pressure of air against any plain surface has two rectangular components, one in the direction of the air rush and varying as the sine square of the angle of incidence, the other perpendicular to this and varying as the sine times the cosine, or nearly as the sine for small angles. This may be seen in Chanute's table of lift and drift heretofore used. The same law may be approximately expressed, for small angles of incidence, by saying the lift varies directly as the angle of incidence, while the drift varies as the square of the angle.

In complainants' machine, according to this law,
983 when the rudder is turned it exerts a torque directly proportional to its angular displacement from the line of flight to counteract the torque of the wing margins which varies as the square of their angular displacement from the line of flight. As a consequence these opposing torques cannot be kept equal for various displacements of the balancing mechanism by any provision disclosed in the patent in suit; and if they were equalized at all working angles for one upward cant of the machine, they would not be so for another cant necessitated by the varying speeds, loads, etc. Thus the opposing vertical torques are adjusted to equality neither
984 for the various instantaneous positions of rudder and lateral wing margins, nor for their average magnitude or effect throughout the whole period and extent of the angular displacements. During the restoration of lateral balance for any given tilt, therefore, the rudder will in general either exert too much torque and spin the aeroplane to the right, say, or it will exert too little torque and thus cause the machine to spin to the left while righting, if indeed the wing warping do not permanently overpower the vertical rudder and upset the machine or allow it to slide off laterally to

inevitable shock against the earth, or "well digging" 985
as it has been termed.

The peculiar liability of this mishap, of the machine of the patent in suit seems apparent from the drawings which indicate a construction in which the rudder torque increases less rapidly than the opposing torque of the wing margins for larger and larger displacements of the controlling cord, so that when the machine receives a tilt beyond a certain value it will overpower the rudder if this be adjusted to exert an equalizing torque at some mean position. The sequence of movements which accompany such disaster to the machine in suit
need not be portrayed here as it is well known 986
from complainants' description and explanation in the specification. Suffice it to conclude from the foregoing argument that the machine of the patent in suit is inherently and by virtue of its construction always in unstable lateral equilibrium, liable to veer excessively from right to left during the process of lateral balancing, and liable to "well digging" or plunging to earth even when operated by a cautious and skilled pilot. Howsoever great, therefore, the stimulus imparted to the art of flying by complainants in practically employing the well known principle of control disclosed by others be-
fore their experiments, the patent in suit is not an 987
important contribution to the science of the aeroplane, since it discloses an impracticable contrivance and advocates a defective theory. The theory is obviously defective in a two-fold sense, first, in endorsing the conjunctive working of rudder and wing margins; secondly, in affirming the necessity in general of working the rudder of an aeroplane in lateral balancing.

In any rational discussion of your question it must be recognized from the outset that in both

988 complainants' and defendants' machine minute changes of orientation about each of the three axes are constantly occurring even with the most skillful use of all the controls; for it is no more possible for a pilot to keep the axis of his flying aeroplane *precisely* fixed in direction than for an astronomer to keep his telescope centered on a star when the observatory foundations are trembling or shifting. With this reservation I declare my opinion that the alleged vertical spin due to lateral balancing is less in defendants' aeroplane without using the vertical rudder than in the patented machine with such use. Nor do I believe that in either machine
989 can the pilot in practical flight prevent, detect or precisely correct, by use of the rudder, the small deviations indicated by theory. If an astronomer attempt to center his telescope on a star by free hand without the aid of microscopic adjustments, the axis of his tube will whip past the desired point a million times before striking it, and once centered will promptly shift away unless held in place by special elaborate mechanism. So also the pilot finds it practically impossible to adjust his rudder so as to turn his aeroplane through a small fraction of one degree without exaggerating the deviation he wishes to correct.

990 Adjourned at 5.30 P. M. to Oct 13th at 11 A. M.

New York, N. Y., Oct. 13, 1911,
11 A. M.

Met pursuant to adjournment.

Present—Counsel as Before

(Answer continued.)

As stated by Orville and Wilbur Wright in their affidavit of November 27th, 1909:

> "The angle of incidence of the main planes varies with every variation in the

direction or force of the wind, with every 991
variation in the power of the motor, with every variation of the path of the machine from a uniform line and with every variation in the load. Both the fact and the reasons for it are well known and may be stated as follows. The flying machine is sustained by the reactions resulting from moving aeroplanes almost edgewise through the air at small angles of incidence. The lifting force thus created varies with the speed and also with the angle of incidence. Since in a flying machine the lift is equal to the total
weight of the machine, it is evident that if 992
the speed is increased, a smaller angle of incidence will furnish the required lift, while if the speed is decreased a larger angle will be required. It is further evident that when two men are carried the angle will be greater than when one is carried, and that when the fuel tank is full the angle will be greater than when empty; and will constantly vary as the fuel is being exhausted. Moreover, when the power of the motor increases or decreases, the speed increases or decreases and causes the angle of
incidence to decrease or increase. * * * 993

As persons having long experience in the use of flying machines we assert that during a flight of one hour the angle of incidence will be either greater or less than any angle which may be named as normal, during more than fifty-nine minutes, and that it will be exactly at the specified angle less than one minute."

994 And my affidavit for complainants executed November 22nd, 1909 states:

> "I have made special investigations with instruments designed to show the variations in the horizontal direction of the wind and have found that the wind varied from the horizontal by as much as 20 degrees at frequent intervals."

Under such conditions suppose the aeroplane of the patent in suit to be navigating toward and for some point due north in level and normal poise. The machine presently receives a tilt,
995 let us say toward the west. In order to rectify this, as explained in the patent in suit, the wings are warped for the purpose of restoring the level so as to prevent gliding sidewise due to the oblique lateral component of gravity. The left-hand wing margins are then given a greater angle of incidence than the right-hand ones so as to exert a greater lift, but at the same time they also sustain greater horizontal pressure than the corresponding parts of the right wing These unequal horizontal forces against the right and left wing tips exert a torque about the vertical axis tending *materially* to change the orientation of the machine and to allow the left
996 wing to lag behind at such diminished relative velocity with reference to the right wing as to cause it to sink unless the vertical spin be checked. The provision made for checking such vertical spin by an opposing torque is a vertical rudder so connected as invariably and constrainedly to turn so as to receive the impact of the air on the side next to the wing having the least angle of incidence, or next to the right wing in the present instance. But owing

to the law of resistance previously stated, the 997
pressure against the side of the rudder and the torque exerted by the rudder about the vertical axis of the machine vary directly as the angular displacement of the rudder, or nearly so. The vertical torque exerted by the wing tips varies approximately as the square of their angular displacement from the line of flight, and consequently if the opposing torques of rudder and wings balance each other for the particular corrective movement made by the operator and at a particular angular displacement, they will not balance for a larger or smaller angular displace-
ment. Hence in attempting to correct the tilt 998
of the machine the controlling mechanism may be by good fortune moved just sufficiently to give the necessary lift to the lower wing, in which case the wing will rise and the opposing torques of the rudder and wing margins will remain nearly equal for that given displacement and no material spin of the machine will be occasioned by such opposing torque, except during the period of warping and restoration of the wings to their normal form and position, and except for any diminution
in the vertical torque exerted by the warped 999
wings which may be occasioned by their varying angle of incidence due to rotation about the longitudinal axis, due to the changing cant of the aeroplane, due to the changing direction of the wind, due to the changing velocity of the aeroplane, etc. Thus with the most favorable operation of the balancing mechanism there is sure to be an unbalanced torque about the vertical axis during a part, if not all, the period during which it is used. As a consequence even though the machine be restored to its natural

1000 level, it will deviate from its course, since it has no other mechanism for preventing or correcting such deviation.

With less good fortune in operating the balancing mechanism, it will at first be displaced the wrong amount, a contingency which is likely to be the rule rather than the exception. If it be displaced too little, the left wing may rise but owing to the excessive torque of the vertical rudder the aeroplane will spin toward the right; if it be displaced too much, the wing torque will overpower the rudder torque, the machine will spin toward the left, the low wing will lag
1001 behind, thus receiving less support while the right wing advancing more rapidly receives greater support.

Recess for Lunch at 1.05 P. M.

Resumed at 2 P. M.

Now this spinning to left in such assumed circumstances cannot be prevented by turning the rudder to the right and thereby still further increasing the already excessive torque of the wings about the vertical axis, while if the rudder and
1002 wings be turned in the opposite direction the righting effort of the lower wing may not be sufficient to cause it to rise. The aeroplane will then continue to tilt and deviate toward the left and descend toward the earth in a spiral course incapable of correction by use of the mechanism for constrainedly warping the wings and turning the vertical rudder. Of course other agencies may be brought into play. The horizontal rudder may be used when the machine is so tilted, either to

change its cant fore and aft and thus change its 1003
velocity, or to change the curvature of its path and so bring centrifugal force into play as opposed to the lateral component of gravity, or to cause the machine to dip sheer downward in order to give the wings equal velocity so that the righting mechanism may again be employed under more favorable conditions. But this is not practical flying.

The erratic veering to right and left and the uncertain equilibrium of the machine in suit may be remedied only by some provision for so relating or coordinating the turn of the rudder to the twist
of the wings as to prevent a considerable resultant 1004
torque on the machine as a whole during the process of lateral stabilizing. But no such provision is disclosed in the patent in suit for any particular cant of the machine, much less for a varying cant in which the relative movement of the vertical rudder and wing tips would have to be differently coordinated. Hence the machine in suit cannot be regarded as capable of practical flight.

1. To summarize, it follows from the foregoing and is admitted by the wording of the patent, that lateral equilibrium cannot be restored in the ma-
chine of the patent in suit without turning the 1005
vertical rudder; therefore the vertical rudder is an indispensable part of the mechanism for restoring the lateral balance. In defendants' machine not only is it not necessary to turn the vertical rudder, but balance can be restored even if the vertical rudder is entirely omitted; therefore defendants' vertical rudder is not a part of the balancing mechanism.

2. The machine of the patent in suit, whenever its wings are warped, will violently swerve toward the side of the greater angle of incidence and upset

1006 unless the rudder is turned toward the other side an amount to check the vertical spin. Defendants' machine, as shown by experiments, even under exceptional conditions and even though the rudder is not turned, does not spin an amount sufficient to be detectable by the aviator.

3. In the machine of the patent in suit the vertical rudder is turned toward the wing having the lesser angle of incidence, and (where a turn of the course is being made) opposite to the direction of the turn, and hence its action tends (though ineffectually), to keep the machine from turning, so
1007 that in no sense is it a true steering rudder. On the contrary, in defendants' machine, if a turn is to be made the rudder is rotated to the side toward which the turn is to be made, irrespective of whether the greater angle of incidence is on that side or the other, and that too whether or not the ailerons are in action. Defendants' rudder is therefore a true steering rudder.

4. The machine of the patent in suit may be deflected to right or left by tilting the machine, and allowing it to slide sidewise, while a change of orientation is accomplished by the difference of horizontal resistance of the warped wings, in op-
1008 position to the influence of the rudder. Defendants' machine is steered to right and left, and has its orientation changed, by the vertical rudder and in accordance with the direction of the rudder's rotation, without using the ailerons at all.

5. In the machine of the patent in suit flying at any given angle of incidence, the more the wings are warped the greater is their difference of resistance and of their consequent torque about the vertical axis. In defendants' machine the difference of resistance, if any exist, due to the movement

of the ailerons, is practically constant however much they be moved. 1009

6. As the patent in suit does not disclose any construction by which the vertical rudder can be moved except by warping the wings, the rudder cannot correct the multitudinous variations in the resultant torque about the vertical axis caused by the changes of the general angle of incidence of the aeroplane during flight, and therefore cannot maintain the course of the machine nor steer it along any predetermined route. The course of the areoplane may possibly be changed by tilting the machine, and allowing it to slide sidewise, but this is
an uncertain and hazardous operation with such 1010
a glider, even for a trained acrobat, and is a species of steering wholly unsuitable for practical flying. The machine of the patent in suit is therefore unadopted to voyage with any security and precision from one given point to another in extended flight, and would not be even though provided with an adequate motor and propeller.

7. Disregarding all other defects inherent in it, it was not until the vertical rudder of the machine of the patent in suit was divorced from the warping wings and made independently moveable by the operator, so enabling him to correct 1011
the multitudinous variations in the resultant vertical torque and to steer the aeroplane, that the Wright machine became in fact a practical flying machine.

8. In my opinion, because of the foregoing differences in mode of operation and results, the defendants' machine is not the mechanical or functional equivalent of the machine disclosed in the patent in suit.

Adjourned at 4:30 P. M. to Oct. 14, at 10:30 A. M.

1012 New York, N. Y., Oct. 14, 1911,
10:30 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

Cross examination by Mr. Toulmin:

By Mr. Toulmin: Without waiving the objections of record as to parts of this witness's testimony, the cross examination is proceeded with.

XQ63. In answering direct question 3 you stated you had made inventions. Have you
1013 invented an apparatus whose object is to prevent the unequal angles of incidence of ailerons from causing, by their difference in head resistance, a turning of aeroplanes on their vertical axis?

By Mr. Newell: Objection is made to this question if it is intended to pry into any invention made by the witness. It is made merely to show that objection is taken to this line of examination if for any improper purpose and to save a right of objection which may become proper in the future.

1014 A. I made such an invention at a time when it was alleged that the ailerons in defendants' machine exert a disturbing torque about the vertical axis of the aeroplane, and before I witnessed experiments to determine whether or not such torque is produced in defendants' machine, at the instant of their operation for lateral balancing.

XQ64. And at that time, that is when made such invention, which was before you wit-

nessed experiments with defendants' machine, 1015
you were inspired to make such invention under the belief that in Defendant's machines the ailerons when at unequal angles did produce a disturbing torque about the vertical axis which required a counterbalancing device to correct it. Is that correct?

A. Without taking into account at that time all of the possible opposing or nullifying agencies of such alleged torque, I concluded from theory that there might possibly be a slight, even though very minute, disturbing torque about the vertical axis momentarily produced by the ailerons during
their brief period of action and that this dis- 1016
turbing cause however trivial might be construed to indicate that an aeroplane so controlled infringes the patent in suit and cannot be regarded as a practical flying machine without the use of the vertical rudder, to offset such alleged disturbing torque.

XQ65. Then you were at one time so far under the belief that defendants' machine came within the Wright patent, that you went to the labor and effort of inventing some contrivance which would eliminate the use of the rear vertical rudder for correcting the turning effect produced
by the unequal angles of the ailerons. Is that 1017
substantially correct?

A. I was under no such belief at all, but recognizing that the alleged torque was a question in dispute, and without serious concern as to how such dispute might terminate or be decided, I made the invention so that it might be available in case the Court should decide that defendants' machine is not practically operative without the use of the vertical rudder to prevent or correct the disturbance, if any, caused by the ailerons.

XQ66. Did you reduce that invention to practice so as to know how it would perform? By

1018 "reducing to practice" I mean did you build and put the apparatus to actual test?

A. After making the invention I had an opportunity of seeing a similar device in operation on defendants' machine, but, answering your question directly, I myself did not build and put the apparatus to actual test.

XQ67. And did you learn who devised the similar apparatus you saw put to test on one of defendants' machines?

A. I made some inquiries, or more exactly speaking, I listened to some remarks volunteered and given in general conversation, which indicate that
1019 several persons claim to have devised the apparatus.

XQ68. Please state where you saw this apparatus similar to yours tested on one of defendants' machines?

A. At several places, but first, I think, at Atlantic City, New Jersey, in July, 1910.

XQ69. Please name the several places referred to in your last answer and give the date of each occasion at those respective places.

A. Another place was the Aeroplane Exhibition held in Washington last Winter, 1911, and at Hammondsport, New York in the Summer of 1911.

1020 XQ70. Who was operating defendants' machine when this apparatus was being tested at Atlantic City in July, 1910.

A. Mr. Curtiss.

XQ71. And who was operating the machine at Hammondsport, N. Y. when you saw this apparatus again tested on one of defendants' machines in the Summer of 1911?

A. The same person.

XQ72. And on whose machine was this apparatus mounted, if on any, at the Exhibition given in Washington?

A. I did not inquire, and I cannot say with certainty. 1021

XQ73. And did the performance of this similar apparatus to yours when you witnessed it under tests on defendants' machines, equal what you contemplated would be the performance or success of your own apparatus for the same purpose?

A. Just at the moment I do not recall witnessing what may be termed rigorous scientific tests, but the apparatus seemed to work satisfactorily in practical flight.

No tests were made to determine whether or not it operated absolutely without any vertical torque, as contemplated in my invention, and so I had 1022
no means of determining whether or not its performance equalled what I contemplated would constitute the success of my own apparatus for the same purpose.

XQ74. You have given a good many opinions in your testimony herein. Will you venture one more and state what you think would be the efficiency of your said apparatus compared with the one you saw Mr. Curtiss operating on his machine and of which you say in answer to XQ73 that "the apparatus seemed to work satisfactorily in practical flight."

A. I think both apparatus would work satis- 1023
factorily in practical flight, but I have not yet inquired into their relative efficiency, nor could I venture an opinion of their relative efficiency for any actual embodiment of the two devices without taking into account all the dimensions and details of construction.

XQ75. And what would you say was the weight of this apparatus you saw Mr. Curtiss operating on his aeroplane?

A. I do not know, nor do I think I could guess accurately.

1024 XQ76. Well as you have seen it two or three times according to your answer already given, can you not approximately state its weight?

A. Understanding by the term "apparatus," and including therein the balancing ailerons, the cords connecting them with the equalizing device, and the yoke which operates this, I should guess that the weight is not over 50 pounds, and is probably less.

XQ77. And how much of the 50 pounds do you estimate would be the additional weight due to the presence on the machine of such apparatus?

A. I should conjecture that the addition of the
1025 equalizing device adds to the usual unbalanced ailerons and controlling mechanism not more than 10 pounds.

XQ78. And would the same be substantially true as to an embodiment of your own apparatus for the same purpose?

A. My own device has never been embodied in actual construction, but I think its weight in actual construction need not exceed ten pounds.

Adjourned to Monday, Oct. 16, at 10:30 A. M.

New York, N. Y., October 16, 1911,
1026 10:25 A. M.

Met pursuant to adjournment.

Present—Counsel as before.

XQ79. Did you invent this device of yours for the purpose stated before or after you were retained by the defendants in this case?

A. As set forth in my statement to the Patent Office, I first conceived the device in September, 1908, disclosed it to others in November, 1909, and thus may be said to have invented the device before the date of my first affidavit in

behalf of defendants, executed February 22, 1027
1910, and which is the date of my first service to defendants in this case.

XQ80. You speak of your "statement" to Patent Office. Do you mean what is known as a preliminary statement filed in the interference proceedings?

A. Yes.

XQ81. Then is there a contest before the Patent Office between yourself and others as to who was the first inventor of this invention in question?

A. There is interference proceeding.

XQ82. Would you mind stating how many ap- 1028
plicants are parties to that interference and the names of the other contestants?

A. Speaking from memory I think there are seven in all, six besides myself. I can give the names by reference to the Patent Office records, but I cannot recall them all.

XQ83. In answering XQ67 you spoke of the conversation in your prescence which indicated that several persons claimed to have devised this apparatus in question. Please name such of the several persons whose names were then stated as you now recall them.

A. There are business reasons why I should not 1029
disclose such names.

XQ84. Have you any interest, I mean financial, immediate or prospective, in any flying machine enterprise, apart from your invention to which we have just been alluding?

A. None whatever.

XQ85. Please name several of the principal writers on the subject of Aeronautics who are regarded as accepted theoretical authorities?

A. I cannot say that any authority would be rigorously accepted in all that he has written, Langley

1030 but Mr. Chanute has, in his "Progress in Flying Machines," given a fair history of the art of aviation up to 1894; Mr. Langley has given a detailed account of some important experiments in aerodynamics; and both of these authors have discussed some of the fundamental principles of aviation. Also Mr. Eiffel has given an account of his experiments on the resistance of the air, and a good summary of experiments made by others. Doctors Finzi and Soldati, of Milan, Italy, Riabouchinski of Russia, and Mr. Lanchester of England have recently published important contributions to the fundamental prin-
1031 ciples of aviation.

XQ86. Do you remember the year when Mr. Chanute's book to which you referred, was sold in bulk as old paper?

A. I do not, but I think it was a year or two after flights on dynamic aeroplanes had been made in this country and Europe. Mr. Chanute told me of this sale two or three years ago and I understood him to say that the sale had just recently been made, possibly in the Winter or Spring of 1908.

XQ87. Do you know whether Mr. Glenn H. Curtiss has also invented an apparatus having
1032 the same objects in view as your own, to which we have before referred?

A. He has applied for a patent on an apparatus functionally equivalent to mine.

XQ88. Have you any contingent fee in this case, that is a fee dependent wholly or in part upon the result of the suit?

A. None whatever.

XQ89. You have spoken of the "normal" angle of incidence of defendants' machine. By "normal" angle, do you mean the angle of the main planes while the machine is in a position of rest as you expressed it in answer to direct question 14?

A. Without referring back to any particular case in which I have used this expression, I should say generally that by the term "normal angle of incidence" of defendants' machine in flight at any given speed and loading, I mean the angle made by the chord planes of the sustaining surfaces with the line of flight when the machine is moving steadily through calm air on a horizontal course. 1033

XQ90. Well, is this normal angle of defendants' machine, which you have in mind in your last answer, the same as the angle of incidence of the main planes while the defendants' machine is in a position of rest as while standing 1034
on level ground?

A. I do not know.

XQ91. The angle of incidence of aeroplanes in flight changes with variations in speed with the same weight, does it?

A. Generally speaking, I should say it does, providing the grade of the course be not materially changed.

XQ92. Well is it not the fact that the angle of incidence of the supporting planes will change with the variation in speed, with the same weight, whether the machine be flying upgrade, downgrade or horizontally when the change of speed takes 1035
place?

A. Yes, providing the particular grade assumed whether up, down or horizontal, remain unchanged. The condition of uniform flight along any grade is that the component of the weight of the machine at right angles to the course of flight shall equal the component of air resistance at right angles to the course and opposite in direction to the component of gravity. This component of gravity is equal to the product of the weight of the machine

1036 by the cosine of the angle between the line of flight and the horizontal line in the same vertical plane. If the line of flight leans a little above or below the horizontal line, the component of gravity differs but little from the entire weight of the machine, but if the aeroplane should fly up a very steep grade at any given speed, the component of gravity to be overcome by the lift of the wings would be less than in approximately horizontal flight, and hence for any given speed the angle of incidence need not be so large for very steep grades as for approximately horizontal ones.

XQ93. And the angle of incidence of aeroplanes
1037 in flight changes with variations in weight with the same speed, for any given grade, does it not?

A. I should say it does under the same atmospheric conditions.

XQ94. And the angle of incidence of aeroplanes in flight changes with variations in both speed and weight—as high speed and light weight, to lower speed and greater weight, for any given grade, does it not?

A. For uniform atmospheric conditions, I should say it does.

XQ95. In all cases of flight with defendants' machines, with which you are familiar, there is a dif-
1038 ference in the angle of incidence of the ailerons when one is upturned and the other downturned, and consequently a difference in drift or head resistance, with the accompanying swerving or turning effect on a vertical axis, save only should such machines fly with their main planes at the assumed "normal" angle of incidence. Is that correct?

A. When the median plane of the ailerons is adjusted for any given speed and loading of the ma-

chine in horizontal flight, I should say as assumed 1039
in my computations hitherto made for defendants, that the angle of incidence will change with the change of weight and speed for any given grade and atmospheric conditions.

XQ96. Well then your answer to my last question is "yes?"

A. Yes, for constant grade and atmospheric conditions.

XQ97. And if defendants' machine were flying upgrade under the conditions stated in XQ95, the answer would still be "Yes," would it not?

A. Yes, with the same qualification as in my answer to XQ96. 1040

XQ98. And if defendants' machine were flying horizontally under the conditions stated in XQ95, the answer would still be "yes," would it?

A. With still the same qualifications, yes.

XQ99. And if defendants' machine were flying downgrade under the conditions stated in XQ95, would the answer still be "yes?"

A. With still the same qualifications, yes, and these last three answers were intended to be conveyed in my answer to XQ95.

XQ100. Should defendants' machines fly with their main planes at other than the assumed "normal" angle of incidence, there would be a difference 1041
in the angle of incidence of the ailerons when one was upturned and the other downturned, and consequently a difference in drift or head resistance, with the accompanying swerving or turning effect on a vertical axis. Is that correct?

A. That assumption has been made merely for the purpose of computation in some of my answers hitherto, but it must be borne in mind that the ailerons are placed between two large and approximately parallel surfaces which tend to guide the air, and thus change its angle of incidence on the

1042 ailerons, giving the direction of air rush an approximately fixed angle of incidence to the median plane of the ailerons, which angle may be very minute. Owing to this consideration, I cannot say positively that there would be a material change in the angle of incidence of the ailerons placed between the main planes, when these change their angle of incidence. It has been shown by Maxim and others, as I remember, that the current of air between the main planes is considerably diverted from its free and undisturbed course, so that its stream lines approximate in direction to the contour of the main planes. Should this observation
1043 be strictly true, it would follow that there is no change in the angle of incidence on the ailerons placed between the main planes when these change their angle of incidence.

XQ101. Aside from the uncertainty you express in your last answer, you confine it to a case where the ailerons are between the supporting surfaces. But inasmuch as you have shown the Curtiss machine in the photograph marked "Zahm Photo No. 2," with the ailerons beyond and not within the main supporting planes, and inasmuch as the same position of the ailerons is shown in Curtiss Photographs Nos. 1 and 2, I will ask you to now answer
1044 XQ100 with respect to the machine with the ailerons positioned as shown in these photographs? I refer to the regular ailerons and not those on the king post 6.

Counsel for defendants objects to the question on the ground that it has not been shown that the machines of the photographs are within the allegations of the bill of complaint, nor was this machine in any way referred to in the *prima facie* case made out by the complainant. For one thing, the bill of complaint alleges joint infringement only,

and the original bill was amended to strike 1045
out the original allegations of "several" infringements. Questions in regard to this arragement indicated in the question are therefore outside of the record as made by the complainant. The question is therefore incompetent to prove or attempt to prove any of the allegations in the bill of complaint.

By Mr. Toulmin: If any answer to the above statement is required, it will be made when defendants' counsel undertakes to get the Court to sustain his objection, and the witness is asked to please answer the question. 1046

A. Each of the ailerons referred to in your question has one-half of its surface in the current of air which passes between the main planes and is diverted by them, while its other half protrudes laterally into that part of the air stream which is less affected by the main planes particularly at the farthest outward extremities of the ailerons. Thus answering directly your question 100, I should say there would be a difference in the angle of incidence of those parts of the ailerons which encounter the undeflected air stream, when one was upturned and the other downturned, and when the 1047
aeroplane flies with its main plane at other than the assumed normal angle of incidence.

Recess for Lunch.

Resumed at 2 P. M.

XQ102. Name the conditions under which defendants' machines will fly at this so-called "normal" angle of incidence.

A. Referring to the definition given in my answer to XQ89, I should say when the machine is moving

1048 steadily through calm air on a horizontal course, or when it moves at this same angle on a sloping course owing to such change of loading as to make the same angle of incidence on the sloping course give just the requisite support in calm air, or in a horizontal current of air of uniform velocity and direction; for I assume that in both horizontal flight and in oblique flight along any straight course a horizontal stream of air of uniform velocity and direction is the equivalent of calm air to an aeroplane moving through it in steady flight.

XQ103. Then your last answer includes or is based upon a "given speed and loading" as you ex-
1049 pressed it in answer to XQ89?

A. I am assuming the machine to be flying with a constant velocity through the air, that is, with a velocity which is constant in magnitude and direction with respect to the onrush of air, but with the loading constant for a horizontal course and less for a sloping course, for the reasons already given. In other words, if the machine lose a part of its weight during flight, it will no longer require so large an angle of incidence to sustain it at a given speed on a horizontal course, and still less angle to support it on a sloping course. On the other hand if the load be increased, the angle of flight
1050 on a horizontal course at the same speed must be increased so as to insure the requisite support, whereas on a sloping course of just the right grade and at the same speed, the requisite support may be obtained without increase of the angle of incidence due to the increase of load.

X104. Now you may name the conditions under which defendants' machines do not fly at the so-called "normal" angle of incidence?

A. In a wind of uniform horizontal speed and direction, which also includes calm air as a special case, I should say that for a given speed through

the air along a steep grade, the angle of incidence 1051
might for a given loading maintain steady flight along the course, assumed as rectilinear, with a less angle of incidence than on a horizontal course. Also in an atmosphere whose velocity is fluctuating rapidly in magnitude and direction, there may be instantaneous changes in the angle of incidence above and below the assumed normal angle of flight. Such changes in the angle of incidence will be less for a swiftly-moving machine than for a slow one, as when for any sufficient cause the general velocity through the air may be assumed to be changed.

XQ105. Does your testimony express substantially this, namely: that whenever in the defend- 1052
ants' machine during flight the angle of incidence of the main planes is other than the so-called "normal" angle of incidence, when and at the times one aileron is upturned and the other downturned, then the ailerons have unequal angles of incidence, and produce a turning torque of the machine on its vertical axis, but that, in your opinion, such turning of the machine is not of sufficient amplitude or duration to require the rear vertical rudder to be used to counteract said turning. Is that your opinion?

A. Before replying to this question I would observe that in some questions you have used the 1053
expressions "turning torque," "turning effect," and "swerving effect," without defining such terms. In order to clarify my answers I wish to say that I have understood the expressions "turning effect," "turning torque," "turning effort," "turning moment," "moment," and "torque" to be synonymous, as they are in the general literature of Engineering and Mechanics, and in all cases to mean merely an effort to produce rotation. Thus one may exert a "torque," a "moment" or "turning effect," a

1054 "turning moment," etc., on a sufficiently resisting body without producing rotation.

Applying this explanation to the case in hand, I would say that if one aileron exert a greater torque than the other about the so-called vertical axis of the machine, their combined effect will be a resultant turning torque equal to the difference of the two and tending to make the aeroplane as a whole spin about said axis. If this resultant torque, however, be opposed by an equal resultant torque due to the pressure of air against the machine, or any other sufficient agency, there will be no turning of the machine as a whole; and if said re-
1055 sultant torque be opposed by a greater or less torque, there will be a tendency to spin about the vertical axis in the direction of the greater or less of such opposing torques as the case may be.

I have not yet had any positive evidence that any such turning of the machine is initiated at the instant the ailerons are worked, and due to their influence.

When any observed phenomenon may be attributable to several causes, real or alleged, independently exerting their influence, the true effect of either one of them may best be studied by eliminating the others. The other causes tending to turn
1056 the aeroplane about its vertical axis at any instant may be the irregular motion of the air itself, the gyroscopic effect of the rotating mechanism and propeller during any slight pitching of the aeroplane, the lateral sliding of the machine due to any slight tilt it may have, In my effort to exclude such other causes and to give the alleged turning torque, due to the working of the ailerons, a chance to show itself, so that I might observe whether it has any value at all and if so whether it tends to spin the machine in the direction or oppositely to that heretofore assumed to be indicated by theory

and by the preamble of the patent in suit, I had 1057
defendants' machine flown in the calmest avail-
able air and in level poise laterally, and along
as nearly horizontal course as might be, over a
field free from obstructions and fairly level but
not perfectly so. Under such conditions, when the
ailerons were so adjusted that their median plane
inclined rearwardly five degrees below the line of
flight and their control cords were tied to the op-
erating rope, the machine was observed to fly with-
out spin about the vertical axis. Also when the
ailerons had their median plane inclined five de-
grees above the line of flight, no spin was observed
under such favorable conditions. This was the 1058
resultant effect on the machine as a whole. We
may conclude from the experiment therefore that
in defendants' machine when flying under such
conditions no perceptible rotation about the verti-
cal axis is caused by the working of the ailerons.

Adjourned, according to the Court's order of Oct. 10th, to Oct. 27th, to 10:30 A. M.

New York, N. Y., Oct. 27th, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before. 1059

(The witness continues his answer to XQ105.)

During the progress of the experiment just described I could observe no turning of the vertical rudder from its neutral position in the longitudinal axis, and the pilot, Mr. Curtiss, told me that he had not turned it in the least.

Now, animadverting to your question directly I will divide it into three parts. You inquire whether my testimony affirms, first, that the ailerons have unequal angles of incidence when the angle of incidence of the main planes is other than

1060 the so-called normal; second, that the ailerons produce a turning torque of the machine on its vertical axis, under such conditions; third, that in my opinion "such turning of the machine is not of sufficient amplitude or duration to require the rear vertical rudder to be used to counteract said turning."

In answering the first of these questions I must recall what was stated in my answer to Q100; namely that the current of air between the main planes is considerably diverted from its free and undisturbed course so that its stream lines approximate in direction to the contour of the main
1061 planes. This is a physical fact about which there is no uncertainty. The fact has been well attested by the careful experiments of several well known students of aerodynamics. Professor Marey, for example, has photographed the stream lines in a current of air flowing past arched surfaces and rendered visible by means of fine smoke streams. These photographs show that the current which flows with uniform velocity along a rectilinear course is deflected by an arched, or wing-shaped, surface, not only near the surface but at a considerable distance from it on either side. Some years ago I made similar experiments in a large
1062 wind tunnel and obtained like results. Also during the adjournment in the taking of this deposition, I placed a small model of the main planes of defendants' machine in a uniform stream of air in order to observe the stream line, and I found that they approximate the curvature of the main planes as in the above cited experiments. The main planes were set at all angles of incidence to the direct current from zero degrees to ten degrees respectively, positive and negative, and the corresponding change in the direction of flow midway between them was observed by means of a wind-

vane delicately poised, the angles of the main 1063
planes and of the wind-vane placed midway between them being accurately measured by means of graduated circles. As a result it was found that the change in the angle of incidence of an aileron so placed would average about one-third the change in the angle of incidence of the main planes for all angles from zero to ten degrees. I conclude from all the foregoing evidence, that in no case is the change in the angle of incidence on the ailerons even approximately equal to the change in the angle of incidence of the main planes between which they are placed.

See if his aff. given us contradicts this. Yes, Sub. contradicted in folio 734 of affdt.

The answer to the second question follows nat- 1064
urally from the answer to the first. Whatever resultant torque the ailerons may produce about the vertical axis, must be very much less than that computed on the assumption that the change in the angle of incidence of the ailerons equals the change in the angle of incidence of the main planes. For, as is well known, the drift on the ailerons, or the horizontal force by which they exert their torque, varies approximately as the square of the angle of incidence for the small angles used in practical flight.

The third question seems to introduce a confusion by the employment of the phrase "such turn- 1065
ing of the machine" as the equivalent of "a turning torque." Obviously the first phrase indicates a rotation, while the second phrase indicates a moment or effort to produce rotation. One may admit that there is a turning moment of the ailerons about the vertical axis without affirming that such moment produces a turning of the machine, as I have explained in the first paragraph of this answer.

As previously stated, I have had no experimental evidence of any turning of the aeroplane about its

1066 vertical axis initiated by the working of the ailerons. The computations heretofore made have shown that theoretically there might be a minute turning of the machine under the conditions there assumed, but such conditions do not obtain in actual flight, but on the contrary, the resultant torque of the ailerons if any exist, must be less than that previously computed, because they are not exposed to the free onrush of air. Finally it has not been proved by computation that any minute torque about the vertical axis, due to the unbalanced drift on the ailerons, will produce a spin about the vertical axis because all of the opposing
1067 agencies have not been taken into account. But by assuming conditions especially favorable to the production of a change of orientation in the machine, it has been theoretically shown that there may sometimes be a minute spin which is undetectable by the aviator in ordinary practical flight, and which if revealed to him by special instruments of precision, could neither be prevented nor adequately corrected by use of the vertical rudder. Even this minute deviation of a fraction of one degree indicated by theory for exceptionally favorable conditions might in most cases be eliminated if all the opposing agencies counteracting the in-
1068 fluence of the ailerons were duly considered.

By Mr. Toulmin: That part of the answer referring to what Mr. Curtiss told the witness is objected to as a hearsay statement. That part of the answer referring to the *ex parte* tests made during the recess or adjournment in the taking of this deposition, is objected to as incompetent, first, because *ex parte*, and second because made, without notice, to assist in meeting a question already on the record when the adjournment took place.

XQ106. In your last answer you say the air 1069
stream in your experiments was found to approximate the curvature of the main planes. By "approximate" do you mean that such air stream in that experiment varied more or less upward from a line midway the upper and lower planes and following their contour?

A. If a reference line drawn fore and aft midway between the main chord planes, and parallel to them be meant in your question, I should say the stream lines of the air current midway between such planes were sometimes slighthly inclined above such reference line, and at other times
slightly inclined below such reference line, accord- 1070
ingly as the main planes were canted considerably upward at the forward edge or considerably downward.

XQ107. And such variation of the stream line, as referred to in your last answer, would vary the relative angles of incidence of the upturned and downturned ailerons, to such line for any given adjustment of such ailerons. Is that correct?

A. The relative angle of incidence of the air rush on the upturned and downturned ailerons would change with the changing angle of incidence of the air rush on the main planes, but at a much
smaller rate. 1071

XQ108. And also in your answer to XQ105 you say; "as a result it was found that the change in the angle of incidence of an aileron so placed would average about one-third the change in the angle of incidence of the main planes for all angles from zero to ten degrees." In such case, with the ailerons adjusted each five degrees from their median line, and the main planes at say 10 degrees angle of incidence, what would be the angle of incidence of the upturned aileron and what the angle

1072 of incidence of the downturned aileron, to this alleged air stream approximately following the contour of the planes?

A. Assuming the normal angle of incidence of the main planes to be five degrees, the change in their angle of incidence would be five degrees for the case assumed in your question, and the corresponding change in the relative angle of incidence of the ailerons would be approximately 5/3 of one degree for the rate of change assumed in the question. Thus the relative angle of incidence would be approximately 6 2/3 degrees for one aileron and 3 1/3 degrees for the other. This of
1073 course is a hypothetical case and I do not testify that defendant's machine ever flew at such large angle of incidence.

XQ109. But the question and answer last given are not hypothetical aside from the 10 degree angle of incidence of the main planes, on the theory that what you testify your experiments show as to diverting the air current by the contour of the planes be true in practice. Is that correct?

A. I referred only to the 10 degree angle of incidence as being hypothetical.

XQ110. And is it further to be understood from your testimony that if the ailerons when at unequal
1074 angles of incidence produce a turning of defendant's machine on its vertical axis sufficient to require the turning to be counteracted, then the rear vertical rudder, being always under the control of the operator, would perform that office when turned toward the aileron whose angle was the less?

A. No. I have testified that the ailerons in the experiments witnessed by me produced no perceptible turning of defendant's machine about its vertical axis, and that my computations have disclosed no such turning of sufficient magnitude to be

detected by the pilot, or to be prevented or cor- 1075
rected by use of the vertical rudder.

Recess for Lunch.

Resumed After Lunch.

In any hypothetical case wherein it is assumed
that the ailerons produce a turning of Defend-
ants' machine about its vertical axis, I cannot
say positively that such turning could be cor-
rected by rotating the rudder toward the aileron
having the less angle of incidence, because the
ailerons when turned respectively above and below
their median plane are exposed to different 1076
kinds of air streams one of which may be swifter
than the other, so that the aileron having the less
angle of incidence to the relative flow of air
may exert a torque equal or superior to that
exerted by the other aileron. In general the
machine as a whole may not have a resultant
torque and consequent spin in the direction of
the resultant torque of the ailerons. Moreover,
the resultant torque of the ailerons may prevail
at the beginning of their righting effort but
be overpowered during the remaining period of
their effort by the increased opposing torque of
various agencies, such as the air resistance on 1077
the operator's body which is inclined to one side
of the center of the machine, the unequal re-
sistance of the wings themselves due to their
rotation around the longitudinal axis whereby
one meets the air at an increased angle of in-
cidence, while the other meets it at a diminished
angle of incidence. If, for example, a wing tip
be rising at the rate of one foot per second
while advancing fifty feet per second, as in
defendants' machine in ordinary flight, the angle
of incidence on such a wing tip is diminished
by rather more than one degree, while the angle

1078 of incidence on the other wing tip is increased by a like amount, thus causing a greatly altered pressure on each of them. It seems impossible, therefore, to establish any general rule as to whether the vertical rudder should be turned toward or away from the aileron having the less angle of incidence, if indeed the rudder require any turning at all.

By Mr. Toulmin: Objected to as irresponsive.

XQ111. In your answer to XQ108 the aileron with the 6 2/3 degree of angle of incidence would
1079 be the downturned aileron, would it not?

A. The downturned aileron would have an angle of 6 2/3 degree to the relative flow of air.

XQ112. And the aileron referred to in the same answer as having 3 1/3 degrees of angle of incidence would be the upturned aileron, would it not?

A. Yes.

XQ113. Under the same conditions as named in XQ108 and your answer thereto, what would be the angle of incidence of the downturned aileron, and what the angle of incidence of the upturned aileron, with the angle of incidence
1080 of the main planes 7 degrees instead of 10?

A. Respectively 5 2/3 degrees and 4 1/3 degrees.

XQ114. Referring again to the patent application you have testified you have filed in the Patent Office on your invention for equalizing the unequal pressure on the ailerons in flying machines, will you state the date of filing of that application?

A. I think it was March, 1910.

XQ115. Do you recall approximately the time the declaration of interference was made?

A. As nearly as I can remember, it was in the latter part of the Summer of 1910, or possibly about mid-Summer. 1081

XQ116. Has any testimony been taken in this interference?

A. I think some testimony has been taken.

XQ117. Can you say about when, and the name of the contestant whose evidence was so taken?

A. Toward the latter part of the Summer of 1911, as well as I can remember. I think the contestant's name is Magrane.

XQ118. Has the testimony on your behalf been yet taken in that case? 1082

A. Not yet.

XQ119. Has the testimony on behalf of Mr. Glenn H. Curtiss been taken in that interference?

A. As far as I am informed, no one's testimony has been taken, except Magrane's.

XQ120. Have you a copy of the application with the accompanying drawings as the same were filed in the Patent Office by Mr. Curtiss in that case?

A. No.

XQ121. Are you willing to produce to be offered in evidence in this case as a part of your cross examination a certified copy of the 1083 application, including the specification, claims, petition and oath and drawings, filed by yourself in the Patent Office relative to this invention referred to above?

> By Mr. Newell: This entire line of examination is objected to, for the same ground as heretofore given. The witness is instructed that he is not obliged to do as requested in the question.

1084 A. For business reasons I prefer not to.

XQ122. If I would pay the cost of such a certified copy, will you produce it?

A. The cost is not a consideration.

By Mr. Toulmin: As Doctor Zahm has mentioned in answer to direct question 62 that he made an affidavit herein on behalf of complainant, and has in answer to direct question 55 identified that affidavit by giving its date as November 22, 1909 in referring to a statement contained in the affidavit, such affidavit is now offered in evidence as a whole on behalf of complainant
1085 to be marked Complainant's Exhibit "Zahm's Complainant Affidavit." The notary is requested to copy the affidavit in the record at this point as it is short.

By Mr. Newell: Objection is made to copying the affidavit in the record, as defendant should not be saddled with the cost of paying for or printing complainant's exhibits. The notary will mark the exhibit, the same as any other exhibit.

By Mr. Toulmin: As the affidavit was twice referred to by the witness in his direct examination, and a statement in the
1086 affidavit was also referred to by the witness, it is thought that the affidavit as a whole should go into this record and be printed, but if counsel declines, then it will be printed in complainant's record.

By Mr. Toulmin: A certified copy of the Zahm affidavit of Nov. 22, 1909, the original now being on record in the Court where this cause is pending, will be handed to the notary to mark, as above requested, before the close of the taking of these depositions.

Redirect examination by Mr. Newell: 1087

RDQ123. In your answer to XQ105 you described experiments which you have made which showed that the course of the air rushing between the main supporting surfaces in defendant's machine would tend to follow the curve of the surfaces, even though the machine were tilted up to a greater angle of incidence, consequently tending to hold the air rush nearly constant in direction with respect to the median line between the ailerons. You have also in your direct examination, shown that if the aeroplane meets a wind having an actual upward trend of, say, 10 degrees with respect to
the horizon, the angle of incidence upon the main 1088
planes of the machine as a consequence thereof would not be increased 10 degrees, but would be a great deal less, 4 degrees in the particular case you mentioned.

As a result of your experiment mentioned in the first sentence of this question, what effect or change in that apparent 4 degree increase would be produced by the effect which the main planes have in holding the direction of air rush from changing as much as it otherwise would?

A. The angle of incidence of the relative air rush against the ailerons would be changed ap-
proximately 4/3 of one degree instead of 4 degrees, 1089
as on the main planes.

RDQ124. In your computations, you did not take into account the effect which the main planes had on the direction of the air rush, tending to hold it more constant. If you had taken this into account would the minute theoretical turning of the machine (under the exceptional condition you assumed) computed by you, be increased or decreased, and why?

A. It would be very materially decreased be-

1090 cause the ailerons would exert a greatly decreased torque below that computed, owing to the much slighter change in the angle of incidence of the relative air rush against them.

RDQ125. In other words, then, the main planes tend to hold the air rush between them more nearly constant in relative direction. Is that correct?

A. Yes.

RDQ126. When were you first consulted by defendant in regard to giving an affidavit in this cause?

A. In February, 1910.

RDQ127. Who was it that asked you to execute
1091 your affidavit of November 22, 1909, which was introduced by complainant on the motion for preliminary injunction?

A. Mr. Wilbur Wright.

RDQ128. What, if anything, did he say to you in regard to his opinion of your qualification in aeronautical matters?

A. I do not recall that he said anything at that particular date, but I recall that in March, 1910, he asked me whether I could accept a retainer as expert witness in his behalf in the present suit, and saying that he would prefer to have me rather than anyone else in such capacity.

1092 RDQ129. You have spoken in your cross examination of a device which you invented which allows the ailerons to yield if there is any inequality of resistance exerted by them, and that you have seen a much similar device used on some machines of Mr. Curtiss. In your device and in his device, when the ailerons have been moved so as to form an angle with each other, both ailerons can yield in the same direction without changing the angle between them and without any further movement of the shoulder yoke. Is that correct?

By Mr. Toulmin: Objected to as an attempt to state in the question secondary evidence of what the devices may be. In view of this question and the admissions of the witness on cross examination, request is made of opposing counsel, as also of the witness, to produce for the examination of counsel for complainant, and if necessary for introduction in evidence in this case, copies of the patent applications and accompanying drawings as the same appear in the Patent Office, of the Zahm and Curtiss inventions referred to in the question. 1093

A. Yes. 1094

By Mr. Newell: Although it is considered that the production of the Curtiss application is immaterial to any question in this case, and is an attempt to pry into an invention made by a competitor of the complainant, for ulterior reasons, defendant's counsel wishes no erroneous impression to be gotten from the non-production, and therefore agrees to produce a copy of the specification and accompanying drawings of the Curtiss application, above referred to, as filed, at the close of complainant's proofs 1095
in this case, for introduction by complainant as one of its exhibits if it so desires, unless circumstances shall show that it is, in my opinion, unnecessary.

By Mr. Toulmin: There is no ulterior motive in calling for this copy. It will be shown to have a legitimate bearing upon the matters testified about by defendant's witnesses. But the offer is so qualified as not to be an offer at all, nor will a copy

1096 of less than the application and its parts as they now appear in the Patent Office be accepted as a compliance with the request, nor anything less than such a copy certified to by the Patent Office. Will counsel please now state on the record whether he will produce such a copy, or not before the close of the testimony for the defendants?

By Mr. Newell: I have nothing further to say, except that the offer asked at this time, in my opinion, shows that there is an ulterior motive in the complainant trying to pry into this construction.

1097 RDQ130. Was any such device in use on any of the machines when the experiments which you have testified to heretofore were made?

A. No.

RDQ131. You have stated in answer to questions on cross examination that your application is in interference with an application of Mr. Curtiss. Have you made any agreement or license to Mr. Curtiss for him to use this device?

A. No.

By Mr. Newell: I regret that I shall be unable to go on tomorrow. I am an officer
1098 in Squadron A, a militia cavalry organization here, and have been detailed as range officer at the Blauvelt Rifle Range tomorrow. I therefore cannot be present. These orders detailing me came in some time ago and I have no control over them but to obey them. Tomorrow is Saturday.

Adjourned at 4:30 P. M. to Monday, Oct. 30th, at 10:30 A. M.

New York, N. Y., Oct. 30, 1911. 1099

Met pursuant to adjournment.

Present—Counsel as before, at 10:45 A. M.

RDQ132. When you made your invention of the device for exactly equalizing the drift on the balancing devices on the two sides of the machine, had you made any experiments or computations to determine how much or how little such inequality would affect the defendants' machine?

A. No. I was aware that a material turning torque was alleged to occur in defendants' machine when the ailerons are worked, and apprehending that in the most general case of any aeroplane 1100
whatever whose lateral balance is maintained by stabilizing surfaces at either side of the machine, there might be an objectionable torque about the vertical axis due to the peculiar design or mode of operation of such aeroplane, I invented the equalized balancing surfaces in order to provide for a righting torque which could be applied without any ensuing and concomitant torque about the vertical axis due to their operation.

RDQ133. In XQ95 the words "swerving or turning effect" were used. Please state what you understood by that expression in answering that question, and in answering XQs 96 to 100? 1101

A. As explained in my answer to XQ105, I meant by "turning effect" and "swerving effect" a moment, or effort to produce rotation, as is commonly understood in the literature of mechanics; in other words, I meant the vertical torque of the ailerons which tends to make the machine spin about its vertical axis, and is resisted by the numerous opposing agencies, some of which have been specified in my testimony hitherto.

RDQ134. Did you or did you not intend to imply that there was actually a turning of the

1102 machine as a whole, or merely that there might under some cases be a tendency to turn if the effect of the ailerons were alone considered?

A. I meant, not that there was actually a turning of the machine as a whole, but that the ailerons might sometimes exert a torque tending to turn the machine, which torque may be balanced or even overpowered by the opposing resistances hitherto specified.

RDQ135. If there should be any turning of defendants' machine on its vertical axis, what influence thereon would the rotating propeller exert?

1103 A. It would exert an opposing influence if the machine were not entirely prevented from pitching.

RDQ136. If you saw the Wright machine (which was afterwards sold to the Government) and which was flown at Fort Myer, Virginia in 1908, by Orville Wright, please state whether or not it had any device by which the vertical rudder could be moved independently of the warping of the wings?

A. Yes, it had. As I remember, the pilot held in one hand two independently operable levers, one for warping the wings, the other for rotat-
1104 ing the vertical rudder, which levers could also be worked conjunctively. When given equal rotation they work conjunctively; when moved one with reference to the other, they worked non-conjunctively. Thus it was possible to warp the wings without turning the vertical rudder or with turning the vertical rudder, as desired. Mr. Orville Wright told me that he very frequently worked the two levers above mentioned, independently, so much so as to cause considerable fatigue to the muscles of his forearm.

RDQ137. If I understand you correctly, the 1105
two levers could be worked together so as to warp the wings and turn the rudder, and then the vertical rudder lever could be worked independently, so as to turn the rudder independently if desired. Is that correct?

A. Yes.

ALBERT F. ZAHM.

Adjourned at 12:20 to 2:00 P. M.

Resumed After Lunch.

Counsel for defendant herewith intro-
duces a photolithographic copy of a portion 1106
of a book entitled "Revue De L'Aeronautic" in French, dated 1893, and requests that the same be marked as Defendants' Exhibit "L'Aeronautique Publication."

Counsel for complainant waives proof that such a book was published as a printed publication in 1893, and also admits that the photolithographic copy offered in evidence is a correct copy, subject to correction if he be found to be in error as to such admission.

ALBERT STETSON, a witness introduced on 1107
behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence and occupation?

A. Albert Stetson; age, 60 years; residence 827 Freeman Street, New York; occupation, patent solicitor and patent expert.

Q2. Will you please state what experience you have had which would tend to qualify you to make translations from the French and German languages into English.

1108 A. I had three years course in French and German in college. After leaving college I taught Natural Science and Modern languages for six years. I then went to Europe as General Manager of the Dolbear International Electric Co. and remained there engaged in technical and scientific work, until 1886. During that time I was a great deal of the time in France and Germany and did a great deal of translating from French and German into English. In 1886 I became acquainted with Grosvenor P. Lowrey, became his technical expert, and spent nearly all the time until 1890 in Europe, mostly in France
1109 and Germany. I might say that I spent the years from 1877 to 1880 in the Universities of Leipzig and Berlin. Since 1894 I had been engaged in the practice of my profession, and have had a great deal of translating to do for use in the Courts. Nearly all of the evidence in the shape of translations from French and German used in the various Bell telephone suits was done by me. I also did a great deal of the same kind of work in the secondary battery suit. The translation in the book by Sylvanus P. Thompson and entitled "Philip Reis, the Inventor of the Telephone," was made by me.

1110 Q3. Have you prepared a translation of the Exhibit "Defendant's Exhibit L'Aeronautique Publication?" If so, please produce it.

A. I have and I now produce it.

The translation mentioned by the witness is herewith offered in evidence, and requested to be marked as "Defendants' Exhibit L'Aeronautique Translation."

Cross examination by Mr. Toulmin:

XQ4. Before you made this translation, did you

have a talk or conference with any one regarding 1111
the points to be brought out in the translation?

A. Absolutely none, even before or since.

XQ5. Do you term this a free or a literal translation?

A. I tried to make my translation as near literal as good English will allow.

ALBERT STETSON.

Counsel for defendant states that he has no witness that he can put on right now. He expected to put on Mr. Willard for the completion of his cross examination as Mr. Willard was available all last week, and he was 1112
expected to go on this morning, but on Saturday Mr. Willard telephoned me that he was suddenly called South on business.

Adjourned at 3 P. M. to to-morrow, Oct. 31, at 11 A. M.

New York, N. Y., November 1, 1911.

Met at 10.30 A. M., instead of yesterday at 11 A. M.

Present—Counsel as before.

Counsel for defendant states that he was 1113
disappointed in not getting a witness yesterday, and therefore spent the day with Dr. Zahm with relation to his testimony this morning.

By Mr. Toulmin: As I am here under notice that defendants would proceed to take their testimony after an adjournment of ten days or more, it would seem that arrangements should have been made for the prompt appearance of the witnesses named in notice. Request is therefore made that such delays be avoided hereafter as com-

1114 plainant is entitled to proper progress while attending under notice. Counsel will kindly observe this request.

By Mr. Newell: I have tried to do so. As I said on Monday, I had arranged to put on Mr. Willard on Monday to conplete his testimony, but Mr. Willard was unavoidably called away on business, which threw my plans into the air. I did not expect to put on Dr. Zahm again for several days, but in order to avoid delay as far as possible, I am putting him on to-day. There will be no delay in completing our testimony within the
1115 time set if I can help it.

Counsel for defendant herewith introduces a copy of "Gliding Experiments" by Octave Chanute, being a reprint from the Journal of Western Society of Engineers of 1897, and requests that the same be marked as "Defendant's Exhibit Gliding Experiments."

Counsel for complainant waives proof that such a pamphlet was published as a printed publication in 1897, subject to correction if found to be in error.

1116 ALBERT F. ZAHM, a witness heretofore introduced on behalf of defendants, having been heretofore sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state, in a general way, what the prior art was before 1901 with relation to gliding flight, the use of vertical and horizontal rudders for steering aircraft to the right and left and up and down, and what, if any, devices were old in the art for maintaining and restoring lateral equilibrium, either by the use of independent balancing sur-

faces or warping the wings of heavier-than-air ma- 1117
chines.

By Mr. Toulmin: I note that an hour and three-quarters have elapsed since the question was put, and up to this time when the answer is about to be made.

A. The practical and permanent art of gliding by man through the air on artificial wings or sustaining surfaces by aid of gravity or the natural wind dates from the experiments of Otto Lilienthal during the last decade of the nineteenth century. Up to the time of his death in 1896 Lilienthal had
executed nearly 2000 gliding flights, ranging in 1118
length up to 300 yards. Both monoplanes and biplanes were used as shown in "Defendant's Exhibit Gliding Experiments" and in "Defendant's Exhibit Wright 1901 Address." The monoplane glider was an arched surface having in its rear a fixed double rudder or tail. The pilot supporting his weight on the glider as shown in the illustrations referred to could in calm air sail down a slope of nine degrees at a speed of nine meters per second, propelled by the force of gravity which expended on the total mass of the machine and pilot during such flight hardly more than two horsepower, as judged by
the rate of descent. The monoplane was controlled 1119
partly by the action of the double tail and partly by the shifting of the pilot's weight. The biplane glider as shown was operated in a similar manner. In 1896, as stated in the Aeronautical Annual of 1897, Lilienthal wrote: "I am now engaged in constructing an apparatus in which the position of the wings can be changed during flight in such a way that the balancing is not effected by changing the position of the center of gravity of the body." He

1120 thus seems to have invented a means for balancing the machine without shifting the center of mass.

Recess for Lunch.

Resumed after Lunch.

In 1895 Percy S. Pilcher of Glasgow, constructed a monoplane glider resembling Lilienthal's but having rather longer and narrower wings which were nearly straight from tip to tip. In this machine also the pilot was supported by his arms and controlled the poise of the glider by shifting his weight. A double rear rudder served to guide and
1121 steady the flight as in Lilienthal's device. Pilcher sometimes sailed down hill and again was towed or launched like a kite by means of a cord running through multiplying gear and drawn by running boys or a horse. He made many flights which exhibited satisfactory equilibrium and control in the air, with the expenditure of about two horse-power by gravity in propelling himself and his glider, aggregating 220 pounds mass.

In 1896 Mr. O. Chanute and Mr. A. M. Herring developed the Chanute biplane gliders shown in "Defendants' Exhibit Gliding Experiments." Their final product is shown in Figs. 235 to 242 of said
1122 exhibit. The wings were straight from tip to tip; the double rear rudder shown in the illustration was connected directly to the main surfaces by a rod and was guyed by elastic cords so as to steady the machine better during its course through the air, and in particular to enhance its fore-and-aft equilibrium, the lateral equilibrium being maintained largely by shifting the pilot's weight. With this apparatus several hundred glides were made, varying in length from 150 to 360 feet, at angles of descent of 7.5 to 10 degrees, and during the six weeks occupied with the experiments, not the

slightest accident occurred either to the operators or to the machine. The craft was found easy to manipulate in launching, sailing and landing, a two inch shift of the pilot's weight being equivalent to a five inch shift on the Lilienthal monoplane. It was steady at a speed of 20 to 40 miles an hour through the air even when the wind was blowing 17 miles an hour over ground. On several occasions the pilot performed not only down hill gliding, but also true soaring flight to an elevation considerably above the initial level. 1123

One main object of these experiments was to work out the problem of automatic equilibrium which Mr. Chanute considered of cardinal importance in an aeroplane particularly in navigating a gusty or turbulent atmosphere. 1124

A particularly meritorious feature of the structural design of the Chanute biplane is the union of two arched surfaces with the Pratt truss form of framing, that is the combination of horizontal spars or girders with vertical posts and oblique guy wires, now so generally used in aeroplane construction.

Adjourned at 4.30 P. M. to to-morrow, Nov. 2, at 10.30 A. M.

1125

New York, N. Y., Nov. 2, 1911.

Met pursuant to adjournment, at 10.30 A. M.

Present—Counsel as before.

(Witness continues his answer.)

The general object of the experiments just described, of Lilienthal, Pilcher, and Chanute, was to design and operate a glider having inherent or automatic stability; but previous to and concurrent with these, many inventions and contrivances

1126 were brought forth by others having for their object aerodynamic control of the machine in flight by means of rudders and stabilizing surfaces operated either by hand or by other suitable agency.

As shown in U. S. Patent No. 97,100, dated 1869, Marriott invented an airship provided with a vertical rudder and a horizontal rudder, both independently workable, and a pair of aileron-like side planes rotating about a transverse axis of the machine, and operable independently of said rudders, the side planes and the rudders all being controllable by the pilot to steer and poise the machine during its flight. The craft was a semi-bouyant
1127 aeroplane which supported itself partly by the gliding impact of the air against the large wing-like surfaces shown in the patent, and partly by the buoyancy of the torpedo-shaped gasbag connected with it. The airship could not rise of its own buoyancy but required the dynamic support of the large planes, as the craft was propelled through the air by the twin screws shown at its sides.

The top view of this craft, Fig. 1, shows the pointed gasbag B, the large side supporting planes E, E, and the pair of aileron-like side planes G, G, turnable about the transverse axis of the machine for the combined purpose of poising and
1128 steering the machine by the impact of the air against their oblique surfaces when turned by the pilot. A side view of this airship is shown in Fig. 2, and a front view in Fig. 3, in both of which the pair of aileron-like side planes are shown at G. In Fig. 1, I shows the combined horizontal and vertical rudders pivoted on a universal joint at its forward end so that it can be independently rotated about either a horizontal or vertical axis so as to bring into play at the will of the pilot either the horizontal rudder *e* or the vertical rudder *d*, or both as may be desired. The twin screws F, F in

Fig. 1 serve to propel the aeroplane forward while 1129
it is sustained by the kite-like action of the large
side planes E, E, assisted by the gasbag B.

In U. S. Patent No. 588,556, dated 1897, Crepar
discloses a semi-bouyant airship, or combined aero-
plane and lemon-shaped gasbag, steered and poised
during flight by means of two rudders independ-
ently operable by the pilot, one a rear vertical
rudder, the other a front horizontal rudder.

In Fig. 1 the lemon-shaped gas-bag 10 by its
buoyancy helps to sustain the torpedo-shaped hull
11 which contains the propelling machinery for
actuating the large rear screw 19 which drives
the craft forward through the air, while the 1130
front horizontal rudder 17 operable by the pilot
directs the machine up and down, and the rear
vertical rudder 22, also independently operable
by the pilot, steers the craft to right or left.
Another view of the front horizontal rudder 17
is shown in Fig. 4, together with its pivot and
mode of support. The main substaining planes
shown at 12, Figs. 1, 2, 3, serve to support the
craft in flight by their kite-like lift supplemented
by the buoyancy of the gas-bag above.

In British patent No. 16,883 dated 1889, Maxim
discloses a passenger aeroplane driven by twin
screws, and controlled in flight by an independ- 1131
ently operable vertical rudder, an independently
operable pair of conjoined horizontal rudders, and
hinged side planes contrived to give automatic
lateral stability when fixed with their outward
margins raised well upward.

Adjourned at 1:00 o'clock for Lunch.

1132 Resumed at 2:00 P. M.

The side view, Fig. 23, shows the pair of conjoined reverse turning horizontal rudders a, b, placed respectively fore and aft of the machine and operable by the pilot independently of the vertical rudder. Thus if the aeroplane be advanced toward the left, it may be canted upward by raising the forward edge of the front horizontal rudder *a* and conjunctively lowering the forward edge of the rear horizontal rudder *b*. The top view of the aeroplane, Fig. 22, shows the manner of pivoting the rudders a, b, at the points a′, b′, and of attaching the control cords
1133 c, d, for reversely rotating the conjoined rudders about their pivots. The side view, Fig. 24, shows the rear vertical rudder A9 independently operable by the pilot, for steering the machine to right and left. The front view of the left-hand side of the aeroplane, Fig. 3, shows the hinged side plane G, inclined well upward at its outer end and thus tending to give automatic lateral stability.

Mr. Maxim states in the patent that all previous attempts to produce an aeroplane for navigating the air had failed, "generally by reason of the great weight of the machine and its
1134 load in proportion to the power of the generator and motor." He says further, "The aerial machines hitherto constructed have been very heavy in proportion to their power, having a weight of from five hundred to one thousand pounds for each horsepower of the motor. Consequently they have failed to rise in the air."

In contrast to this I am credibly informed that the aeroplane motor designed and used by Mr.

Curtiss weighs between three and four pounds 1135
per horsepower.

In British patent No. 9478 dated 1842, Henson discloses a wheel mounted monoplane driven by twin screws and controlled in the air by a fixed dorsal fin, or keel surface, and by a rear horizontal and a rear vertical rudder, both independently operable by the pilot.

Fig. 1 shows a top view of the machine with its covering removed from the main planes in order to show the manner of trussing them. Fig. 2 shows the same view with the covering applied, and furthermore discloses the dorsal fin, or fixed keel cloth stretched from the front mast A 1136
to the rear mast B, with its upper edge enclosing the wire 8. This keel cloth is adapted to serve as a fulcrum, or bearing surface on the air, to furnish a reaction for the vertical rudder; also to give automatic lateral stability, and to steady the aeroplane about its vertical axis. The fanlike rear horizontal rudder shown in Figs. 1 and 2 is still further disclosed in Figs 5 and 6, together with the cords T, T, attached to the extremities of the vertical spar P of the horizontal rudder for rotating this rudder up and down about its horizontal axis. Fig. 3 shows an underside view of the machine as seen by one stand- 1137
ing below it and looking upwards. This view discloses the vertical rudder Z hung on the upright P and turned in either direction by cords affixed to the ends of the bar Z′ The cords just described, both of the horizontal and vertical rudders, are independently operable by the pilot, thus enabling him to steer the aeroplane to right or left and up or down as desired.

Adjourned at 5:00 P. M. to to-morrow, Nov. 3, at 10:30 A. M.

1138 New York, N. Y., Nov. 3, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

(Witness continues his answer.)

The trussing of the main planes disclosed in Figs. 1, 4, 7, is very efficient and closely resembles that of a good practical monoplane of the present day. As shown in Figs. 4, 7, the transverse main bars C, D, of the main planes are effectively stiffened by means of the king-posts A and F, F, in combination with the tension or guy wires at-
1139 tached as shown in Fig. 4. Across these main bars and the central bar G of Fig. 7 are placed numerous longitudinal ribs which are covered top and bottom with a closely woven fabric, thus forming practically airtight wings of permanent and efficient shape, being convex above and slightly concave below, and having their internal framing effectually shielded from the resistance of the air.

The patents of Marriott, Crepar, Maxim, and Henson each discloses a horizontal and a vertical rudder independently operable by the pilot, devices which are in common use on aeroplanes of the present day. Maxim's patent discloses a pair
1140 of conjoined front and rear horizontal rudders in combination with a rear vertical rudder, each rudder system being independently operable by the pilot, an arrangement successfully used on aeroplanes of the present day.

As will be explained presently, the patents of Mouillard, Harte, Johnston, Mattullath, and Boulton each discloses a device for changing the angle of incidence of ailerons or lateral balancing surfaces, the patent in each case bearing a date prior to 1901. Furthermore, the patents of Boulton and Johnston each discloses a three-rudder system of control, consisting of a vertical rudder, a horizontal rudder, and lateral balancing surfaces or ailerons, by which the pilot can at will exert a torque about each of the three axes of the aeroplane as done in practical flight at present. The Boulton patent also specifies a pair of conjoined reverse turning vertical vanes or rudders, designed to steer the aeroplane to right and left as disclosed in Wright's French patent #384,124. 1141

The patents of Mouillard, Harte, Johnston, Mattullath, and Boulton will now be explained in detail.

In U. S. Patent No. 582,757, dated May 18, 1897,
Mouillard discloses a soaring machine, or an aerial 1142
glider designed to be harnessed to the pilot and controlled in flight by means of a fixed rear horizontal rudder of variable spread, in combination with a pair of wings adapted to swerve fore and aft about a central vertical axis so as to keep their center of lift over the center of mass of the whole craft, and further having flexible rear marginal tips provided with suitable control cords by which the pilot can change their angle of incidence as desired, thus enabling him to exert a balancing torque about the longitudinal axis, or to turn the machine about the vertical axis for purposes of
steering to right and left. 1143

Recess for Lunch.

Resumed at 2 P. M.

Fig. 1 shows a top view of the glider with its two slightly overlapping wings turning about the vertical pivot C, and each having at its rear inward margin a rigid horizontal tail K, the pair being so disposed that when the wings swerve backward, as shown in Fig. 12, the overlapping tails K expose less surface, and the center of support of the over-

1144 lapping and partly closed wings comes to the rear of its previous position. By this peculiar fore and aft swerving of the wings their center of support can be brought directly over the center of mass, forward or aft, thus enabling the pilot to control the up and down pitch or cant of the machine. Fig. 2 is a front view of the machine showing the vertical pivots C, D, in the breast plate of the pilot's harness and supporting the wings so that he may move them to and fro as desired so as to control his up and down course in the air. Figs. 1 and 2 also show flexible rear wing tips having cords O running through rings P thence to handles
1145 Q by which the pilot can turn down the fabric of the wing tips as shown in Fig. 10 for the purpose of changing their lift or drift, and thus exerting a balancing torque about the longitudinal axis of the glider, or a steering torque about its vertical axis.

In British patent #1469 dated 1870, Harte describes a wheel mounted monoplane propelled by a single rear screw, and having wing tips with rear marginal flaps hinged to them and provided with control rods independently operable by the pilot whereby he can turn them in the same or in opposite direction as may be desired. The rationale
1146 of their action is thus explained in the patent:

"The motion of the fans of the screw propeller being rotary tends to give a rotation to the whole machine in the opposite direction. This I counteract by means of the flaps of the wings, each of which acts upon the principle of a ship's rudder, and their combined action is such that when one flap is turned up and the other down they simply counteract this tendency of the machine to rotate and keep it steady. When both flaps are depressed the machine will descend, when both are equally raised it will ascend, and when both are raised but

unequally the machine will make a curve towards 1147
the side on which the flap is most raised."

Fig. 5 shows a top view of the left wing *g*, with its flap *y* and hinge *h* independently operable by the lever *l* for the purpose above stated and explained.

In U. S. Patent No. 722,516, dated 1903, and applied for in 1894, Johnston discloses a semi-buoyant aeroplane having a front vertical rudder and a rear horizontal rudder, each independently operable by the pilot, and having a pair of ailerons or side balancing planes designed to exert a torque about the longitudinal axis of the machine for the
purpose of maintaining its lateral equilibrium, the 1148
pair of ailerons being also operable by the pilot independently of the horizontal and vertical rudders. This patent discloses the complete three-rudder system of control now generally used on aeroplanes, which enables the pilot to exert a torque at will about either of the three rectangular axes of the machine for the purpose of steering and balancing.

Fig. 7 shows a perspective view of the semi-buoyant aeroplane with its gas chambers H, its inclined sustaining planes C, its front vertical rudder D^3, its rear horizontal rudder L, and its pair of ailerons
rons L′, L′. The top view, Fig. 1, and the side 1149
view, Fig. 2, disclose more fully the main sustaining plane C and the mechanism of the controlling surfaces, as also of the longitudinal surface D which serves as a vertical keel. The operation of the vertical rudder, the horizontal rudder, and the ailerons is explained in the patent as follows:

> "At the front end of the partition D is the vertical rudder D^3, which is controlled by suitable tiller chains or ropes *d*, running over pulleys to the hull A. * * *

1150 To the rear of the inclined aeroplane is hinged a horizontal rudder or elevation-regulator L, which is operated by *cords* 1 and serves to control and maintain the desired angle of elevation of the ship. At each side of the regulator L are smaller horizontally hinged blades L′, which are also under control of the engineer and serve to elevate or depress either side of the ship, and thus aid in maintaining equilibrium."

Adjourned at 4:30 P. M. to tomorrow, Nov. 4, at 10:30 A. M.

1151

New York, N. Y., November 4, 1911,

Met pursuant to adjournment, at 10:30 A. M. Present—Counsel as before.

(Witness continues his answer.)

It is evident from the foregoing description that the front vertical rudder is designed to steer the craft right and left, and that the rear horizontal rudder "operated by *cords* 1" is intended to control and maintain the desired angle of incidence of the main plane, and to steer the craft up and down in the air. As stated in the
1152 patent, the ailerons L′, L′, "serve to *elevate* or *depress* either side of the ship, and thus aid in maintaining equilibrium." From this it is evident that the ailerons are intended to exert an equilibrating or balancing torque about the longitudinal axis, whether they be operated independently like the well known Farman ailerons, or conjunctively in opposite directions like the well known Curtiss ailerons. The patent first states that the vertical rudder is controlled by suitable tiller chains or ropes, then states that the horizontal rudder is operated by cords, then finally states that the ailerons "are *also*

under control of the engineer," from which it is 1153
evident that each one of the three rudder systems is controllable by the engineer independently. It is further evident that if the action of the ailerons should tend to turn the craft about its vertical axis, this, if sufficiently great to be noticeable, can be prevented or corrected by the use of the front vertical rudder.

In 1899 Hugo Mattullath disclosed to me his invention of a heavier-than-air aeroplane, presently to be described, on which he applied for a patent in January, 1900, and which was provided with a three-rudder system of control by
which a torque could be exerted at will about 1154
each of the three rectangular axes of the machine for purposes of steering and balancing. As one of his consulting engineers and scientific colleagues, I assisted him in making his patent application, and cooperated with him in his preliminary experiments in aerodynamics and structural design which should form the basis for the complete plans of a passenger-carrying aeroplane. I was present when he disclosed his general drawings, plans and estimates to prominent engineers and scientists, several of whom served as his consultors or advisers during
the preliminary experiments. He formed a stock 1155
company, erected an aerodynamic laboratory, and with a corps of assistants spent nearly two years investigating air resistances on various structural forms; also propelling mechanism, strength of materials, etc. But shortly before he was ready to present his final computations and plans to his council of engineers, he died of apoplexy; and in course of time his patent application was abandoned. He made these disclosures of his invention to many persons in the United States,

1156 stockholders, engineers, workmen and others during 1899 and 1900. He died December 31, 1902.

The general plan of his aeroplane comprised several superposed sustaining surfaces mounted on two parallel catamaran-like hulls for enclosing machinery and passengers, and capable of moving along the ground on wheels or arising from the water as might be preferred. An independently operated vertical rudder at the rear of the craft served to steer it to right and left. Three ailerons along each side of the aeroplane, each independently rotatable about a transverse axis, served to exert a balancing or righting torque
1157 about the longitudinal axis of the aeroplane, or to steer it up and down as might be desired. Thus, if the ailerons on one side of the craft were made to lift more than those on the opposite side, they would tend to tilt the machine laterally or prevent such tilting, at the option of the pilot; while if the pair of ailerons at one end were made to lift more than the pair at the other end they would tend to steer the machine up and down or to prevent any objectionable up and down movement or pitching, at the will of the pilot. The pair of ailerons amid ships, though unnecessary for steering and balancing, might
1158 be used at times to exert a continuous righting torque to prevent listing of the craft should one hull be more heavily loaded than the other.

Recess for Lunch.

Counsel for defendant herewith introduces a certified copy of the application of Hugo Mattullath, deceased, filed Jan. 8, 1900, as corroboration of Dr. Zahm's description, and requests that it be marked as Defendant's Exhibit Mattullath Application."

Adjourned at 2:45 to Monday, Nov. 6, at 10:30 A. M.

New York, N. Y., Nov. 6, 1911. 1159

Met pursuant to adjournment; at 10.30 A. M.

Present—Counsel as before.

(Witness continues his answer.)

Referring to Mattullath's patent application just
introduced, Fig. 1 represents a side view and Fig.
2 a top view of the aeroplane as a whole. In both
these views Q represents a vertical rudder inde-
pendently turnable about the vertical shaft R by
the pilot for steering the craft to right and left as
desired. In Fig. 2, C, C, C are three ailerons, or
movable stabilizing surfaces, placed on either side
of the aeroplane, each independently rotatable 1160
about its transverse axis D, to be operated in-
dividually or collectively at the will of the pilot,
their rotation being affected "by means of levers
D or other suitable means under control from with-
in the car." Thus if the forward pair of ailerons
be given a different angle of incidence from that
of the rear pair, the machine can be made to rise
or fall at the bow; while if the ailerons on one side
of the areoplane be given different angles of in-
cidence from those on the other side the vessel can
be made to tilt to right or left as desired. Figs. 1
and 4 show the sustaining surfaces of the aero- 1161
plane, of which B and E are the fixed main planes
and O, O are auxiliary sustaining planes whose
angles of incidence are adjustable to permit of
trimming the structure for its normal flight. As
explained in the words of the patent application,

"The adjustability of the aeroplanes O and their arrangement in groups fore and aft and to opposite sides of the longitudinal center permits of trimming the structure for its normal flight, while the movable aeroplanes C, which are in charge of a trained crew are for steering the machine in the

1162 vertical plane as well as for maintaining the stability."

This patent application clearly discloses a three-torque system of steering and stabilizing surfaces whereby the pilot can at will cause the aeroplane to turn about either of its three rectangular axes or check such turning as may be desired. The drawings of this patent application were shown to and explained to many persons in the United States, by Mr. Mattullath during the period from 1899 to 1901, particularly to his financiers, consulting engineers and scientists, and his laboratory associates.

1163

By Mr. Toulmin: The exhibit of the Mattullath application is objected to as the same was abandoned in the Patent Office of the United States and is not a publication or capable of use as an anticipation, even if pertinent, under the Statutes. The testimony of the witness concerning the Mattullath so-called experiment is objected to as relating merely to an abandoned experiment which never came to any practical result.

In British patent No. 392, dated 1868, Boulton discloses a three-torque system of steering and
1164 stabilizing surfaces whereby the pilot can at will exert, independently or collectively, torques about the three rectangular axes of an aeroplane, or "an inclined plane or surface, by the motion of which through the air upward pressure is produced and the vessel supported in the manner which is well understood and has often been described." To preserve the lateral balance of the machine he provides a pair of ailerons of the well known Curtiss type operable "either by hand or by self-acting mechanism." He further provides that vanes or

ailerons similarly controlled may be used to keep 1165
the aeroplane on its course both vertically and
horizontally. He first explains in minute detail
the placement and working of a pair of lateral bal-
ancing surfaces or ailerons for exerting a torque
about the longitudinal axis, then states in one
sentence, as obvious, that a similar mechanism may
be used for exerting a torque about each of the two
other rectangular axes. The text of the patent
follows:

> "For the safety of aerial vessels it is impor-
> tant to provide a controlling power, not only
> to direct their horizontal and vertical course, 1166
> but also to prevent their turning over by ro-
> tating on the longitudinal axis. A certain
> stability of the kind desired is afforded by us-
> ing an extended surface whose sides make an
> angle from the axis upwards as has previously
> been described by others. But it is desirable to
> provide a more powerful action preventing ro-
> tation of the body in this direction. For this
> purpose a rudder of the following construction
> may be adopted: Vanes or movable surfaces
> are attached to arms projecting from the vessel
> laterally or at right angles to its length. When
> these vanes are not required to act they pre- 1167
> sent their edges to the front, so as to offer little
> resistance to the vessel's movement, but if the
> vessel should begin to rotate on the longitu-
> dinal axis the vanes are moved so as to take
> inclined positions, those on the ascending side
> of the vessel being caused to rotate to such an
> inclination that the air impinging upon them
> exerts a pressure downwards, while those on
> the descending side are so inclined that the air
> impinging upon them exerts a pressure up-
> wards; thus the balance of the vessel is re-

1168 dressed and its further rotation prevented. The vanes may be moved by hand or by self-acting mechanism." * * *

"Vanes acted on by self-acting mechanism of a kind similar to that above described may also be used when desired for keeping the vessel in a fixed course, both vertically and horizontally.

The text of the patent together with Figs. 5, 6, 7, completely discloses and explains the working of the pair of lateral balancing surfaces, or ailerons of the Curtiss type, when operated automatically by a suitable weight, but which, as stated in the
1169 above quotation, may also be operated "by hand or by self-acting mechanism." The text follows:

"Figure 5 represents a transverse section of a plane fitted with rudders constructed according to my invention to prevent its turning over on an axis in its line of motion through the air. *a* is a section of the plane which is supposed to have taken a position inclined to the horizon; *b* and *c* are two vanes mounted on axes one at each side of the plane, so that it can be turned round like a throttle valve; *d* is a heavy body sus-
1170 pended by an endless cord, which passing over guide pulleys is wound for several times on barrels on the axes of *b* and *c*. When the plane takes an inclined position, as represented in the Figure, the weight *d* tending to hang vertically under the centre of gravity tightens the cord on one side and slackens it on the other, and thus causes the vanes *b* and *c* to turn into inclined positions upon their respective axes. The cord is so wound upon the barrels *b* and *c* that while the one is caused by the action of *d*

to rotate in the one direction the other ro- 1171
tates in the opposite direction.

"Figure 6 represents an end view of *b* and Figure 7 an end view of *c* when these vanes are turned to suit the oblique position of *a* in Figure 5. The plane being moved through the air in the direction of the arrow *e* the air presses upon the under surface of the vane *c* and on the upper surface of *b*, and thus tends to restore the plane to its horizontal attitude."

In passing it may be noted that in each of the aileron vanes *b*, *c*, the axis of rotation is placed
forward of the center of surface, as commonly 1172
practiced in the construction of rudders and stabilizing surfaces, to prevent an excessive pressure forward of the axis.

The device as thus far explained discloses three pairs of stabilizing or steering surfaces capable of being operated by the pilot individually or collectively to exert a torque about each of the three rectangular axes of the aeroplane; first a pair of ailerons of the Curtiss type for exerting a righting torque about the longitudinal axis; second a pair of horizontal vanes or rudders, one fore, the other aft, for steering the machine up and down in its
course, as provided by Maxim, Curtiss and others; 1173
third a pair of vertical vanes or rudders, one fore, the other aft, for steering the machine to right or left, as provided for in Wilbur and Orville Wright's French patent #384,124.

Recess at 1 P. M. for Lunch.

Resumed at 2 P. M.

It is obvious from the foregoing disclosure that any one skilled in the art can successfully apply Boulton's three pairs of rudders—the pair of lateral

1174 or balancing rudders, the pair of fore and aft vertical steering rudders, the pair of fore and aft horizontal steering and balancing rudders—to any ordinary flying machine whether biplane or monoplane, for purposes of maintaining its proper poise and course in the air.

On September 14th, 1911, I observed Mr. Curtiss at Hammondsport, N. Y. make good practical flights, with excellent control, in one of his biplanes provided with a pair of Boulton's ailerons as shown in "Defendant's Exhibits Curtiss Photographs #4 and #5, the flights being made in a quite unsteady wind of five to ten miles an hour.
1175 The ailerons, which were suitably stiffened and measured 29 x 59 inches, were mounted on shafts having their bearings in the front edges of the upper main plane, and were caused to rotate in opposite directions by an endless aileron cord affixed at its center to the pilot's yoke, and passing thence in reverse directions over pulleys 3 shown in Photograph #4. The machine was flown in a straight line, then successively in a curvilinear course to left and to right, in each case maintaining its poise and steadiness with apparently as much facility as when operated with the ordinary Curtiss ailerons. The aeroplane was purposely rocked to
1176 and fro about its longitudinal axis, and banked at a considerable angle as it turned to right or left, in order to give the action of the Boulton ailerons a fair test; and this without the aid of any other lateral stabilizing surfaces, the regular Curtiss ailerons having been removed for the experiment.

In Defendant's Exhibit "L'Aeronautique Publication" and translation of the same, Ader discloses a wheel mounted monoplane propelled by a tractor screw, and governed in flight by a three-torque system of control comprising; first, a rear vertical rudder for steering to right and left; sec-

ond, wing bending and wing warping mechanism 1177
by which the wings can be given different angles of incidence with respect to one another for maintaining lateral equilibrium; third, wing swerving mechanism by which the wings can be drawn considerably forward or rearward to bring the center of support vertically over the center of gravity of the craft, or to its front or rear in order to maintain its fore and aft poise or to steer it up and down. Each of these three rudder systems is independently operable by the pilot, and the three are designed to be used by him individually or collectively, as may be preferred, for purposes of
steering and balancing. 1178

In Plate XIV, Fig. 1 shows a top view and Fig. 2 a front view of Ader's slow speed type of monoplane propelled by a single tractor screw propeller, as commonly used nowadays. Plate XII shows a side view of the same monoplane with the pilot's seat V and the three control levers before it, while beneath the rearward downcurving tail is a vertical rudder Z′ separate therefrom, pivoted at its front and, together with the rear wheel of the chassis, independently turnable about its vertical axis. As stated in the text:

> "The tail is made with ribs like those of
> the wings and furthermore, it can have 1179
> below, and even above, a vertical rudder Z which can be seen on Sheet XII. These two rudders are operated from the inside. * * * When the aeroplane has a vertical rudder it is fixed in the same plane as the rear wheel, and is manœuvred in conjunction with it."

Adjourned at 4:45 P. M. to tomorrow, Nov. 7th, at 10:30 A. M.

1180 New York, N. Y., Nov. 7, 1911.

Met pursuant to adjournment.

Present—Counsel as before. 10:30 A. M.

By Mr. Newell: To-day is a legal holiday, being Election Day, but the testimony is proceeded with in order to avoid delay.

Figs. 1 and 2 of plate XIV show the bat-like wings of Ader's slow-speed monoplane. As explained in the text "Their frame work consists of an S shaped arm B; of a forearm A B curved forwards and at the same time downwards; of a hand
1181 M carrying the thumb and four fingers D, D2, D3, D4, having phalanges;—these fingers and these phalanges have curves appropriate to the shape of the wings. All parts of the framework are articulated in such a manner that one can make them assume the positions necessary for flight. * * * The phalanges of the fingers can be lowered or raised vertically; it is the same for the feet. This operation which is destined to increase or to diminish the arching of the universal curve [*i. e.*, curve of the sustaining surfaces] is shown in Fig. 28. Aside from this, the elbow U turns on itself, and consequently carries with it the forearm, the hand
1182 and its fingers. This action is for the purpose of warping the tip of the wing, so as to destroy or reestablish equilibrium in the wings."

The foregoing paragraph specifies two separate and independent operations each of which can be made to exert a torque about the longitudinal axis of the aeroplane. These operations are: first, the flexing of the fingers whereby the rear margin of the wing tip can be raised or lowered; second, the bending of the wing at the elbow whereby its forearm is raised or lowered, thus raising or lowering the front margin of the outer part of the wing.

We may notice first the mechanism for wing bend- 1183
ing, then the mechanism for finger flexing.

The mechanism for wing bending is thus disclosed in the text. "The forearm A B is connected with the arm B by the elbow (Fig. 30 and Sheet XIV, Fig. 1);

Fig. 30.

tendon C keeps it up and another tendon D keeps it down and supports the strain during the action of flight. The forearm turns upon itself at the elbow, thanks to the tendon T and pulley. These tendons T of the left and
that of the right are connected together so 1184
as to compensate each other; to avoid the concussion of sudden strains they are furnished with an auxiliary muscle M in their course. These tendons are governed by other tendons C and D^2 coming from the inside and put in motion by the (foot) pedals L, or other devices. Above the elbows there is another tendon E making similar movements. Thus then when one forearm turns one way, the other turns in the opposite one." In other words, when one forearm turns up the other turns down, and vice versa. Since, as explained in the text; and since the wing covering is elastic and remains
always taut, it is evident that the raising of the 1185
forward edge of one wing and the simultaneous lowering of the forward edge of the other causes the two wings to present to the air rush different angles of incidence, and thus to exert a righting or balancing effort, or "to destroy or re-establish equilibrium in the wings."

Recess at 12:35 for Lunch.

Resumed at 1:30.

The mechanism for finger flexing is thus disclosed in the text. "Figure 33 shows in diagram

1186 an arrangement of the tendons for working the phalanges of the fingers and of the feet. These tendons are worked by levers, such as L; everything is in perfect equilibrium. During flight

Figure 33.

the action of the air under the wings meets there its resistance, but if one or the other of the levers is worked separately, as can be seen by noting the course of the tendons, the equilibrium is destroyed and the resistance to the air changes in location by the fact of the changing of the inclination of the phalanges; if the two levers are lowered at once, the equilibrium
1187 is not destroyed, but all the phalanges are lowered and there is an accentuation in the curvature of the spiral or universal curve of flight. In this diagram only the tendons of one phalange per finger are represented; it is, of course, the same for the other phalanges. One can, moreover, vary these combinations in order to work the phalanges separately. * * * The tendons for movement slide over or turn about pulleys; they are of silk cord, or cat-gut, or metallic wires."

Adjourned at 3:30 P. M. to-morrow, Nov. 8th, at 10:30 A. M.

1188

New York, N. Y., Nov. 8, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

(Witness continues his answer.)

The disclosures made in the foregoing paragraph are more fully detailed in "Defendant's Exhibit Ader, Fig. 33A" and "Defendant's Exhibit, Ader Fig. 33B" and "Defendant's Exhibit

Drawing, Ader Wings Warped," the first two being enlargements of Fig. 33 of the text and representing top views of the skeleton of the wings and tail of Ader's machine, together with their control cords, pulleys and operating levers A, B, while the third represents a front view of the aeroplane with its wings warped. 1189

In Fig. 33A which delineates the mechanism for reversely warping the wings, the control levers A, B, are supposed to move in opposite direction, as explained in the text, and to place in tension the control cords or tendons marked in red, while at the same time relaxing the
tendons marked in black. The red tendon at- 1190
tached to lever A when pulled draws its two branches round the stationary pulleys 17, 18. Of these two main branches the right-hand one has two sub-branches, one of which directly pulls down phalange 6 of the right wing tip, while the other sub-branch passes freely around pulley 11 without disturbing it and without moving phalange 5; also the left-hand main branch has two sub-branches, one of which directly pulls down the left leg E, or left side of the tail, while the other sub-branch passes freely around pulley 10 without disturbing it, and without mov-
ing phalange 2 of the left wing tip. While the red 1191
tendon of lever A is acting as just described, the red tendon of lever B pulls its two main branches around the stationary pulleys 19, 20. Of these two main branches the right-hand one has two sub-branches one of which directly pulls up the right leg E or right side of the tail, while the other sub-branch passes freely around pulley 8 without disturbing it and without moving phalange 5 of the right wing tip; also the left-hand main branch has two sub-branches one of which directly pulls up phalange 1 of the left

1192 wing tip, while the other sub-branch passes freely around pulley 9 without disturbing it and without moving phalange 2 of the left wing tip. During the combined operation of all the pulled cords, as described in the foregoing sentences, the relaxed cords yield sufficiently to permit such operation, while at the same time keeping the whole structure of the wings and tail properly stretched and taut. The net result of all the operations described is to lower phalange 6 of the right wing tip and raise phalange 1 of the left wing tip, thus warping the wing tips in opposite directions, while at the same time, lifting the
1193 right-hand side of the tail and lowering the left-hand side. The final effect on the wings is portrayed in "Defendant's Exhibit Drawing Ader's wings warped," in which the right margin 6 is shown turned down, while the left margin 1 is turned up an equal amount. Thus the angle of incidence on one wing tip may be diminished by any amount desired even to the extent of becoming negative, while the angle of incidence on the other wing tip is increased by a like amount. In Fig. 33B which delineates the mechanism for identically warping the wings, the control levers A, B are supposed to move
1194 in the same direction, as explained in the text, and to place in tension the control cords or tendons marked in red, while at the same time relaxing the tendons marked in black. The minute details of the operation for warping the wings in the same direction need not be explained here as it is sufficiently obvious from Fig. 33B and from the explanation already given of Fig. 33A.

It is evident from the foregoing paragraph and from the Exhibit Drawings therein explained, that the flexing of the fingers there shown causes the

wings to change their angle of incidence to the air 1195
rush; and furthermore that the angle of incidence of one wing may be increased while that of the other is diminished, thus enabling the pilot to exert a balancing torque about the longitudinal axis of the aeroplane by the manipulation of control wires or tendons affected from the inside of the machine by windlasses or other devices. The said manipulation consists merely in working the specified levers L, L, also indicated in red ink by A and B, in opposite directions, or more simply by working a single lever if the two be connected by an endless cord passing over two pulleys as shown in
the bottom of Fig. 33. The effect of such manipula- 1196
tion when executed so as to increase the angle of incidence of the right wing tip and diminish that of the left wing tip is shown in "Defendant's Exhibit Drawings Ader Wings Warped."

The text thus far examined discloses ample means for exerting independently a torque about the vertical axis and a torque about the longitudinal axis for the purposes of steering and balancing. As will be briefly explained, it further discloses a device for exerting a torque about the third or transverse axis by means of a wing swerving mechanism, independently operable by the pilot,
whereby the wings can be drawn considerably 1197
forward or rearward, to bring the center of support vertically over the center of gravity of the craft, or to its front or rear in order to maintain its fore and aft poise or to steer it up and down.

The wing swerving mechanism and its rationale are sufficiently disclosed in the following passages of the text: "There is another general movement which consists in carrying the whole wing forwards or backwards by making it pivot on its shoulder joint. The object of this capital movement is to

1198 place in equilibrium all the centers of action of the air on the wings with the center of gravity of the aeroplane. These manœuvres are conducted from the inside of the body when in full flight, by means of tendons. * * * To carry the entire wings forward or backwards the tendons are arranged as on Sheet XIV. By pulling tendon C, the wing is drawn forward; by pulling tendon B2, it is carried backwards; and so it is with the tendons A′ and B′ which are safety tendons. The control of these tendons is effected from the inside by windlasses or other devices."

1199 Recess for Lunch at 1 P. M.

Resumed at 2 P. M.

Having explained Ader's device for exerting a torque at will about each of the three rectangular axes of the aeroplane, it may be remarked as obvious that, should the reverse warping of the wing tips for the purpose of balancing, tend to spin the machine about its vertical axis, such spinning can be prevented, if desired, by means of the independently operable vertical rudder.

The conclusions to be drawn from the foregoing
1200 review of the prior art may be summarized as follows:

1. Aerial gliders, both monoplane and biplane, were well known in the art of aviation previous to the year 1901; as for example those of Lilienthal, Pilcher, and Chanute. These were capable of carrying a passenger and of being controlled in flight.

2. Prior to 1901 vertical rudders for steering an aeroplane to right and left at the will of the pilot were well known; as for example the rear vertical rudders of Henson, Crepar, Maxim, Ader and Mat-

tullath; the front vertical rudder of Johnston; the 1201
front and rear reverse turning vertical rudders of Boulton.

3. Prior to 1901 horizontal rudders for steering an aeroplane up and down on its course were well known; as for example the rear horizontal rudder of Henson, and Johnston; the front horizontal rudder of Crepar; the front and rear horizontal rudders of Boulton, and Maxim.

4. Prior to 1901 ailerons and wing-warping mechanism for controlling the lateral poise of the aeroplane were well known; as for example the
ailerons of Boulton, Johnston, Harte and Mattul- 1202
lath; the wing-warping devices of Mouillard and Ader; and all these except the ones of Harte and Mouillard were operated by the pilot at will either together with or independent of the vertical rudder, while conversely the vertical rudder could be operated either together with or independently of such ailerons or wing-warping mechanism.

Defendant's counsel herewith introduces in evidence certified copies of United States Letters Patent to Mouillard, No. 582757, dated May 18, 1897; Marriott, No. 97,100, dated Nov. 23, 1869; Crepar, No. 588,556
dated August 24, 1897; Johnston, No. 722,- 1203
516, dated March 10, 1903; Application for Johnston patent No. 722,516; certified copies British patents to Boulton, No. 392 of 1868; Henson, No. 9,478 of 1842; Harte, No. 1,469 of 1870; Maxim, No. 16,883 of 1889; and a printed copy of French patent to Wright (Orville and Wilbur) No. 384,124; and the two enlarged views of Fig. 33 of the Ader publication, and the drawing of the Ader Wings Warped, referred to by the witness, and requests that they be marked as Defend-

1204 ant's Exhibits "Mouillard Patent No. 582,757;" "Marriott Patent No. 97,100;" "Crepar Patent No. 588,556;" "Johnston Patent No. 722,516;" "Johnston Application;" "Boulton British Patent;" "Henson British Patent;" "Harte British Patent;" "Maxim British Patent;" "Wright French Patent No. 384,124;" "Ader Fig. 33A;" "Ader Fig. 33B;" and "Drawing Ader Wings Warped."

By Mr. Toulmin: Objection is made to Defendant's Exhibit "Ader Fig. 33A" and Defendant's Exhibit "Ader Fig. 33B" on the ground that the same are incompetent under
1205 the law relating to printed publications, as these exhibits contain matter not found in the original Ader publication, namely red lines, full black lines, and numerous reference numerals and letters.

Objection is also made to Defendant's Exhibit "Drawing Ader Wings Warped," as incompetent under the law relating to printed publications.

All three of these exhibits constitute, the former two, in part, and the latter wholly, new matter not found in the Ader publication elsewhere offered in evidence by defend-
1206 ants.

All the testimony of Dr. Zahm relating to these exhibits is also objected to as incompetent, as it relates to matters not found in the original publication in question.

Q2. In regard to the Exhibits Fig. 33A and Fig. 33B, has any change been made in them which is not contained in Fig 33 of the L'Aeronautique publication, except to trace over some of the dotted lines of Fig. 33 in red ink and others in black ink, and to put on the identifying numerals and letters?

A. No, except to enlarge the diagram uniformly.

Q3. In those enlargements, which are the movable pulleys? 1207

A. Those numbered 8, 9, 10, 11.

> By Mr. Toulmin: Objection is made to the testimony of the witness relating to the Lilienthal, Pilcher and Chanute and Herring gliders, as incompetent because secondary, the publications relating to those machines being the best evidence of what they may have been.
>
> Without waiving these several objections, the cross examination is proceeded with.

Cross examination by Mr. Toulmin: 1208

XQ4. Did you ever see a Lilienthal gliding machine in operation?

A. I have seen one of the monoplane type mounted for exhibition, but not in operation.

XQ5. Then the testimony you have given concerning that machine was your version of what you have read concerning it and its gliding operation. Is that correct?

A. Substantially so, except that I have heard Mr. Chanute say that he had a Lilienthal monoplane constructed and operated in 1897.

XQ6. Did you ever see a Pilcher monoplane glide in this country? 1209

A. I have not.

XQ7. Then is it also true that your testimony about that machine is your version of what you have read about it?

A. My testimony is founded largely upon what I have read about it in the English technical journals and in other aeronautic literature.

XQ8. You have testified that the Pilcher glider had a double rear rudder as in Lilienthal's device. This so-called rudder was in fact, according to the publication, a rear tail composed of two vanes

1210 intersecting one another at right angles and secured together as one piece, was it not?

A. So far as I have ascertained, it was a fixed double tail, not operable by the pilot.

XQ9. Did you ever see Mr. Chanute or Mr. Herring glide with the Chanute glider?

A. I saw Mr. Herring with a biplane of the Chanute type in 1898, but I did not see him glide with it; I also saw a full-sized Chanute glider, but not with anybody operating it.

XQ10. Then the testimony respecting the performance of this glider, which you have given, is your version of what you have read on the sub-
1211 ject. Is that correct?

A. Not precisely; it is founded on what I have read, together with what I have heard from Mr. Chanute, from Mr. Chanute's son, from Dr. Alport, who was the attendant physician during Chanute and Herring's glider experiments, and from Mr. Herring. Mr. Octave Chanute, the inventor of the glider in question, died in 1910, and his son, who described the experiments to me, died in 1911.

By Mr. Toulmin: The latter branch of the answer is objected to partly as hearsay and otherwise as incompetent.

1212 XQ11. These Lilienthal, Pilcher and Chanute gliders depended upon the pilot, whose body hung down from the lower plane, shifting himself from one position to another in efforts to maintain the machine in balance?

A. The Chanute glider, as I remember seeing it, and as described to me by the inventors and as described in the printed accounts of it, was provided with a rear double rudder elastically connected to the main planes so as to preserve the longitudinal or fore and aft, equilibrium automatically, while the lateral balance was maintained largely by shifting of the pilot's weight. The Pil-

cher and Lilienthal gliders so far as I have ascer- 1213
tained, had fixed rear double tails, and had their poise in flight both lateral and fore and aft controlled largely by the shifting of the pilot's weight, aided of course by the natural or inherent stability of the gliders due to their structural forms.

Adjourned at 4:30 P. M. to to-morrow, Nov. 9th, at 10:30 A. M.

New York, N. Y., Nov. 9, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

Cross examination continued. 1214

XQ12. If the patent to Marriott describes in the specification maintaining or recovering lateral balance through instrumentalities operated by the pilot on the machine, please quote the language.

A. So far as I can ascertain, neither said specification, nor my testimony concerning it, describes maintaining or recovering lateral balance through instrumentalities operated by the pilot on the machine.

XQ13. Does the Marriott specification say that
the machine would be "poised," or only that its
elevation would be controlled by the planes G? 1215

A. It specifically states that by turning these planes to the proper angles, the elevation of the car can be regulated, and it is also obvious from the nature of the apparatus described that the use of the lateral planes G in combination with the rear horizontal rudder enables the pilot to poise the machine on its course up and down through the air; in other words, to control its fore and aft poise.

XQ14. But the Marriott specification says nothing about "poising" the machine, does it?

1216 A. It does not employ that term, though it does describe mechanism for controlling the attitude of the machine in flight.

XQ15. You have referred to this patent as showing a "vertical rudder and a horizontal rudder." This rudder is in fact composed of two planes intersecting each other at right angles and connected together as one piece, so that any movement would carry both planes, is it not?

A. The planes are connected immovably with respect to one another and at right angles, but they are turnable at the option of the pilot either about a vertical axis or about a transverse axis,
1217 so as to bring either plane into effective operation as a rudder independently of the other plane, that is without the functioning of the other plane as a rudder.

XQ16. But the Marriott specification limits the movement of this tail or rudder by saying it may be turned to stand at any desired angle "either up or down." Do you find any statement in the specification that it is to be turned on a vertical axis or to either side?

A. I find no mention of turning the rudder on a vertical axis, but the specification speaks of the combined planes as forming *a* vertical and
1218 *a* horizontal rudder; and the patent specifically states that "a tail or rudder is also attached to the rear pointed end [of the vessel] by means of which *any* required direction can be given to the vessel when it is in motion."

XQ17. Is this tail or rudder shown in the drawing connected with the remainder of the machine in any way?

A. It is shown in a separate sketch, but the passage just quoted makes it obvious that the double rudder is attached to the rear end of the vessel.

XQ18. In the patent to Crepar, does the specification refer to maintaining lateral balance? 1219

A. So far as I can ascertain, neither said specification, nor my testimony concerning it, describes maintaining lateral balance.

XQ19. The Crepar specification says that the vertical rudder and the bladed wheels 23 and 24 are used to steer to one side or laterally, does it not?

A. It states that "with the wind in the right direction the adjustment of the rudder 22 will coact with the twin screw-wheels 23 in steering the ship;" also "that the rotation of the winged wheel 24 will have a tendency to push the 1220
bow of the ship laterally, and as said wheel is to be run in either direction by suitable means, the sailing craft may therewith be turned to head it in a desired direction." It further states that "A rudder 22, constructed of light strong material and having correct proportions, is hinged by one end to the frame 20, so as to project its blade rearward and dispose it edgewise in a vertical plane." It further discloses tiller ropes for turning this rudder about a vertical axis.

XQ20. And no function is stated in the specification for the vertical rudder unassisted either by the twin screwwheels 23 or the winged rotat- 1221
ing wheel 24?

A. The function of the vertical rudder is not separately described, so far as I observe, but its construction and control "by an operator in the cabin" are described without reference to the twin screw-wheels 23 or the winged rotating wheel 24, and the natural function of the vertical rudder in an aeroplane was very well known in the art at the date of the patent.

1222 By Mr. Toulmin: All of the answer after the word "observe" is objected to as volunteered and irresponsive.

XQ21. Does the Crepar specification state any function for the so-called aeroplanes 12 which are rigid platforms located at the sides of the shell 11, which is to contain gas?

A. It does not specifically state any such function, but the function may be inferred from the name itself, from the drawings of the patent, and from the following sentence which refers to load-carrying: "The shell 11 is strengthened
1223 internally by any suitable means to adapt it to sustain the load it may have to carry, and at each side of said shell similar aeroplanes 12 are longitudinally extended and firmly secured, these being preferably formed of rigid material."

XQ22. Does your last answer mean that the implied function of the aeroplanes 12 is to assist in strengthening the shell 11?

A. It means primarily that the aeroplane is designed to exert a dynamic reaction upon the air, which is the function generally implied by use of the term aeroplane; it means further that the drawings of the patent disclose an aeroplane
1224 whose dynamic reaction can be made to exert a lift for the purpose of carrying a load; and it further means that I understand from the sentence quoted that the aeroplanes 12 are firmly secured to the shell 11 for the purpose of sustaining a part of the whole weight of the machine during flight.

XQ23. As your answer imports into the matter what is not in the specification, I will ask you to quote the words of the Crepar specification which state any function for the planes 12, and that you let the matter rest with such quotation.

A. As stated in my answer to XQ21, it does 1225
not specifically state any such function, and hence I cannot quote the words as requested.

XQ24. You have mentioned the British patent to Maxim No. 1683 of 1889. Was the machine of that patent ever built in the United States?

A. Not to my knowledge.

XQ25. And you know, as a matter of published information, that substantially the machine of this patent was constructed in England and when tried failed to fly in a voyage through the air or even to wholly leave the ground, do you not?

A. So far as I am aware, it was constructed in
England, but never given a trial flight off the 1226
ground; on the contrary, the chassis on which the Maxim aeroplane was mounted was constrained to run along a track from which it was prevented from rising by special rails some inches above and parallel to the rails of the ground track. In a sense, however, it made a voyage through the air inasmuch as it lifted its entire weight together with one or more passengers and flew just above the ground, exerting pressure against the upper or restaining rails.

Recess at 1 P. M. for Lunch.

1227

Resumed at 2 P. M.

XQ26. And the experiment referred to in your last answer ended the career of the Maxim machine referred to?

A. As I remember the published accounts, several flights were made similar to the one described sometimes with one or more pasesngers or other extra burden, and on one occasion the lift of the machine was so great as not only to sustain its

1228 weight and load, but even to break away the upper rail which was designed to keep it from rising during the experimental period while the inventor was studying the art of working the controls. Of these several experiments I do not recall which was the final one, but as I remember the account, the work was discontinued for lack of funds, after the expenditure of a considerable sum of money, whose exact figure I do not remember.

XQ27. In speaking of this Maxim patent you have stated "it may be canted by raising the forward edge of the front horizontal rudder *a* and conjunctively lowering the forward edge of the rear
1229 horizontal rudder *d*." If the Maxim specification so states, quote the language which makes that statement.

A. Said statement is in my own words and founded on the following passages of the specification: "It is evident that a machine for navigating the air must be steered vertically as well as horizontally, that is to say, it must be steered in such a manner that it will move in a horizontal plane, or will ascend or descend as required. * * *

"In the modification of my invention shown in Figures 22 and 23, the kite or aeroplane is provided at its forward end with what I term a bowsprit rud-
1230 der *a* and at its rear end with an adjustable tail *b*. The said rudder *a* is pivoted at a′ and is adjustable by means of cords *c* for the purpose of effecting the vertical steering of the machine. The tail *b* is pivoted at b′ and is adjustable for the same purpose by means of the cords *d*."

These sentences taken together with Figure 23 clearly justify the statement referred to in your question.

XQ28. Then the Maxim specification does not state that these rudders are to be used "conjunctively?"

A. I do not observe that either the patent or my testimony specifically states that these rudders *are* to be used conjunctively, but it is obvious from my quotation in answer to XQ27 that they *may* be used conjunctively. 1231

XQ29. Well, I ask you again does the Maxim specification say that these rudders are or may be conjunctively operated? In answering please confine yourself to the question.

A. The question as I understand it comprises two questions: first, whether they are conjunctively operated; second, whether they may be conjunctively operated. The first of these questions I have just answered. Replying to the second, I do not observe that the patent specifically states that the rudders may be conjunctively operated, but the passages quoted in my answer to XQ27 state that the rudders are pivoted and adjustable for vertical steering by means of cords provided for rotating them, and there is no reason why the cords of both rudders may not be pulled so as to operate them conjuctively. 1232

XQ30. You have also testified that the hinged side plane G of the Maxim patent would tend to "give automatic lateral stability." If the specification makes that statement please answer by simply quoting the language. 1233

A. I do not observe that the specification specifically makes that statement, but I remember reading some published account in which Mr. Maxim assigns that property to aeroplane surfaces placed at a dihedral angle; moreover, it is an obvious property well known in the art before Maxim's invention.

By Mr. Toulmin: All of the answer after the word "statement" is objected to as volunteered and non-responsive.

1234 XQ31. You say you do not observe that the specification specifically makes that statement. Does it make the statement at all, that the plane G will tend to give "automatic lateral stability?"

A. Not that I observe, but my statement that the side planes G set at a dihedral angle tend to give automatic lateral stability to the machine is none the less correct as expressing a well known property of planes or sustaining surfaces so placed.

By Mr. Toulmin: All of the answer after the word "observe" is objected to as volunteered and non-responsive.

1235 XQ32. In referring to the British patent to Henson of 1842, you stated that the "keel cloth" was adapted to "give automatic lateral stability." If the Henson specification so states, simply quote the language.

A. It does not so state, as far as I observe, but the expression is none the less correct, as it simply states what is well known in the art.

By Mr. Toulmin: All of the answer after the word "observe" is objected to as volunteered and non-responsive.

XQ33. You have spoken of the British patent to
1236 Boulton as having a vertical rudder and a horizontal rudder. Are these rudders or either of them shown in the drawings of the Boulton patent?

A. I do not observe that they are disclosed in the drawings, but they are clearly disclosed in the wording of the patent.

XQ34. Does the drawing of this Boulton patent show means for controlling the fore and aft balance?

A. Not that I observe, but the text clearly discloses such means.

XQ35. You have also testified that this Boulton 1237
patent discloses what you have termed a "three-rudder system of control." Does the drawing of this patent show this alleged three-rudder system?

A. Not that I observe, but the drawing shows a pair of ailerons or lateral rudders for exerting a torque about the longitudinal axis, as clearly explained in the text of the patent, both in principle and operation; and furthermore the text clearly discloses similar mechanisms for exerting a torque about each of the other axes.

XQ36. If the Boulton specification describes a vertical rudder and a horizontal rudder and says
that they are to co-operate with lateral balancing 1238
surfaces or ailerons, please answer this question by quoting the language of the specification which so states.

A. The language is very brief, but follows an elaborate and complete description of the principle, construction and operation of the pair of ailerons for exerting a torque about the longitudinal axis of the machine, for the purpose of balancing. It reads as follows: "Vanes acted on by self-acting mechanism of a kind similar to that above described may also be used when desired for keeping the vessel in a fixed course, both vertically and
horizontally." This passage obviously discloses an 1239
independently operable vertical rudder, or pair of reverse turning vertical rudders, to be placed at the front and rear ends of the machine and a horizontal rudder, or a pair of reverse turning horizontal rudders to be placed at the front and rear ends of the machine. The specification, as far as I observe, does not describe in detail a vertical rudder and a horizontal rudder, nor say that they are to co-operate with lateral balancing surfaces, but to one skilled in the art it is obvious that the

1240 three systems of rudders disclosed in the patent can be made to operate individually or collectively for steering and balancing.

XQ37. You say in your last answer that the passage quoted discloses "an independently operable vertical rudder, or pair of reverse turning vertical rudders." You use the alternative or disjunctive "on." So do you mean this passage discloses a vertical rudder or a pair of reverse turning vertical rudders. Which do you mean?

A. I mean a pair of reverse turning vertical rudders, which I may sometimes for brevity call the vertical rudder," in the sense that the pair con-
1241 stitute one compound rudder.

XQ38. And by "reverse turning," do you mean that the members which compose this so-called compound rudder or pair of rudders, turn in opposite directions to each other, that is reverse directions?

A. Yes; the component rudders of the pair turn so that their torques conspire to produce a resultant torque about the vertical axis of the machine.

XQ39. Then would you say that these supposed vertical rudders or this pair of vertical rudders when so reversely turned would move the forward edge of one to the right and the forward edge of the
1242 other to the left, or vice versa?

A. Substantially so.

XQ40. Is it your notion that these supposed vertical rudders or this pair would stand with the members abreast or in tandem?

A. To one skilled in the art it is obvious that they should be placed at opposite ends of the machine, as expressed in my answer to XQ36. It is equally obvious that they should not be placed abreast, because in that case they would neutralize each other when turned reversely and exert no torque on the machine at all. Thus answering your question directly, they should be placed in tandem. 1243

By Mr. Newell: As it will be impossible to complete defendant's testimony, in all probability by November 14th, the time now set, defendant's counsel gives notice that on Tuesday, Nov. 14th, at the Court room or in Judge Hazel's chambers, in Buffalo, at 10 A. M. or so soon thereafter as counsel can be heard, he will move the Court for an extension of the time now limited to defendant. 1244

By Mr. Toulmin: As I have several times advised opposing counsel, I shall resist any extension of defendant's time for reasons which will be submitted to the Court. I would like counsel to state, however, what amount of time he intends to ask the Court for.

By Mr. Newell: Merely sufficient time to put in a full defense as now laid out. I had expected to complete it within the time now limited, but find that it will be impossible. I have every hope of completing it within two weeks of the time now set. 1245

Adjourned at 4.45 P. M. to to-morrow, Nov. 10th, at 10.30 A. M.

New York, N. Y., Nov. 10, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

(Cross examination continued.)

XQ41. You have also stated that the Boulton patent discloses "the pair of fore and aft vertical

1246 steering rudders." Quote the language of the Boulton specification which says there is a "pair of fore and aft vertical rudders."

A. I do not observe that I have made that statement in very direct language, but I will now make the said statement and substantiate it by citing my answer to XQ36. The passage reads "The language [making the disclosure in question] is very brief, but follows an elaborate and complete description of the principle, construction and operation of the pair of ailerons for exerting a torque about the longitudinal axis of the machine, for the purpose of balancing. It reads as follows:
1247 'Vanes acted on by self-acting mechanism of a kind similar to that above described may also be used when desired for keeping the vessel in a fixed course, both vertically and horizontally.' This passage obviously discloses an independently operable vertical rudder, or pair of reverse turning vertical rudders, to be placed at opposite ends of the machine." Now, replying to your question directly, I do not observe that the language of the patent says specifically there is a pair of fore and aft vertical rudders, or uses the expression "a pair of fore and aft vertical rudders."

XQ42. And does the specification of Boulton
1248 state that there is a "pair of fore and aft horizontal steering and balancing rudders?"

A. It clearly discloses such a pair of rudders in language unmistakable to one skilled in the art, but I do not observe that the specification uses the expression "a pair of fore and aft horizontal steering and balancing rudders."

XQ43. And this unmistakable language you refer to is the quotation from the patent embodied in your answer to XQ41?

A. The quotation taken together with the elaborate description of the principle of construction

and operation of the pair of lateral balancing aile- 1249
rons and the drawings disclosing same.

XQ44. In your direct examination you state that the Johnston patent #722,516 discloses a "three-rudder system of control." If the Johnston specification describes maintaining and controlling lateral balance by means of such a system, quote the language which makes that statement.

A. The three-rudder system of control is disclosed both in the drawings and in the wording of the patent. The following passages may be quoted: "At the front end of the partition D, is the vertical rudder D^3, which is controlled by suit-
able tiller chains or ropes *d*, running over pulleys 1250
to the hull A." * * * "To the rear of the inclined aeroplane is hinged a horizontal rudder or elevation-regulator L, which is operated by cords *l* and serves to control and maintain the desired *angle* of elevation of the ship. At each side of the regulator L are smaller horizontally-hinged blades L′, which are also under control of the engineer and serve to elevate or depress *either side* of the ship, and thus aid in *maintaining the equilibrium*." Thus while the patent clearly discloses a three-rudder system of control, I do not observe that it uses this particular expression in describing the system
of rudders; that is to say the expression "three- 1251
rudder system of control."

XQ45. You have also stated that the patent to Mouillard discloses a glider with a pair of wings "having flexible rear marginal tips provided with suitable control cords by which the pilot can change their angle of incidence as desired." If the Mouillard specification states that the angle of incidence of the flexible marginal tips is changed, quote the language.

A. The drawings and specification of the patent clearly discloses flexible marginal wing tips whose

1252 angle of incidence can be changed by the pilot by suitable control cords. The following passages of the patent may be quoted: "A portion J′ of the fabric at the rear of each wing is free from the frame at its outer edge and at the sides. It is stiffened with suitable blades or slats N, of flexible material, and normally rests up against the netting. Cords O are attached to the rear edge of the portion J′ and pass forward to rings P, where they unite and run to the handles Q near the inner ends of the wings. A pull upon one of these handles causes the portion J′ to curve downward, as shown in Fig. 10, and thus catch the air,
1253 increasing the resistance upon that side of the apparatus and causing it to turn in that direction." Also claim 12:

"12. A soaring-machine having wings adapted to move in horizontal planes, a portion of the fabric covering each wing being stiffened by flexible slats and having its rear edge free from the frame of the wing, and cords attached to said rear edge for pulling it downward, substantially as described."

Thus while I do not observe that the patent states specifically that the "angle of incidence of the flexible marginal tips is changed," the draw-
1254 ings disclose such change and the wording of the patent makes clear that such change of the angle of incidence is intended, and provided for.

XQ46. But the specification does not say so. Is that correct?

A. I have just answered that question in the last sentence of my previous reply.

XQ47. Well, do you say that the specification does or does not so state? Please give a direct reply.

A. It does not specifically state that the "angle of incidence of the flexible marginal tips is changed," but both the drawings and the wording of the patent make it obvious to one skilled in the art that both the purpose and provision of the invention are to change the angle of incidence of the rear marginal wing tips. 1255

XQ48. You also stated that this alleged change in the angle of incidence of the marginal tips enabled the patentee "to exert a balancing torque about the longitudinal axis." If the specification so states, please quote the language.

A. It does not so state, so far as I observe, but the fact is nevertheless true and obvious to one skilled in the art, and was well known in the art previous to the date of the patent; that is to say, 1256 that the change in the angle of incidence of the rear marginal wing tips of an aeroplane enables the pilot to exert a balancing torque about the longitudinal axis; providing of course that the changes of angle of the two wing tips be not of the same mangitude and direction.

By Mr. Toulmin: Objection is made to the testimony of Dr. Zahm regarding the alleged invention of Mattullath, as incompetent, first because the application of Mattullath was abandoned in the Patent Office; and second because the testimony shows it was 1257 an abandoned experiment merely. Without waiving these objections, the cross examination is continued.

By Mr. Newell: The record, however, shows that the device of the Mattullath application was known to Mattullath and others in the United States. The certified copy of the application is merely corroborative of what was so known.

By Mr. Toulmin: And the record herein shows that Mr. Mattullath died without ever building the apparatus, as Dr. Zahm states.

1258 XQ49. In your direct testimony you stated that Mattullath disclosed to you a heavier-than-air aeroplane and applied for a patent. You said the apparatus "was provided with a three-rudder system of control by which a torque could be exerted at will about each of the three rectangular axes of the machine for purposes of steering and balancing." If the Mattullath abandoned specification so states, please quote the language?

A. It does not specifically make this statement in those words, but the drawings and wording of the patent clearly disclose a three-rudder system of control by which a torque can be exerted at will
1259 about each of the rectangular axes of the machine for purposes of steering and balancing. The following passages may be quoted: "C are movable aeroplanes overhanging the sides of the cars A. They are secured to shafts D journaled in suitable bearings and are adapted to be set *at any desired angle* by means of levers D′, or other suitable means under control from within the cars." * * * "The movable aeroplanes C, which are in charge of a trained crew are for *steering the machine in the vertical plane as well as for maintaining the stability.*" * * *

"16. In a flying machine of the character de-
1260 scribed, the herein described means for maintaining its lateral stability, the same consisting in supporting it upon its sides on two boat-shaped cars extending longitudinally thereof and dividing equally between them the principal part of the weight in combination with two series [of] aeroplanes carried along the outer sides of said cars, one [series] on each car and adapted to be individually adjusted to different angles with the plane of flight." * * *

"Q is a rudder secured on a vertical shaft R and extending above and below the deck E substantially the whole height of the superstructure above the cars." 1261

My statement that Mattullath's invention provides a three-rudder system of control is further substantiated by the fact that Mr. Mattulath so explained it to myself and other persons in the United States, as mentioned in my direct testimony.

By Mr. Toulmin: The last paragraph of the answer is objected to as incompetent.

XQ50. But the matter you have quoted does not state that there is any cooperation or conjoint use of the side planes C and rudder Q, does it? 1262

A. It does not so state, as I observe, but the passages quoted taken together with the drawings clearly show that the planes and rudder can be operated either independently or conjunctively for purposes of steering and balancing.

XQ51. But the specification states no function for the rudder Q and does not even say that it is adjustable, and the drawings show no means of operating this rudder. If these statements are not correct, then quote the passages in the specification which give a function to the rudder Q and state that it is movable? 1263

A. No such passage occurs, so far as I observe, but the drawings of the patent clearly disclose a movable rudder pivoted in a quite usual manner well known in the art and obviously intended for steering purposes. As the rudder is pivoted on a single vertical shaft well in front of its center where movable rudders intended for steering are commonly pivoted, and as no other part of the rudder is shown attached to the machine, it cannot be regarded as a fixed rudder. To one skilled in the art no further description of a vertical rudder for steering is

1264 necessary. Moreover, Mr. Mattullath explained to me and to others in the United States that the vertical rudder was designed to be used for steering.

By Mr. Toulmin: All of the answer after the word "observe" is objected to as volunteered and non-responsive, while the reference to statements of Mattullath is objected to as incompetent.

Recess for Lunch at 1:15 P. M.

1265 Resumed at 2:05 P. M.

XQ52. You have stated that the publication relating to the alleged Ader machine discloses "a rear vertical rudder for steering to the right and left." The only description given of this rudder in the translation is that it turns with the wheel to guide the machine on the ground. Is not that correct?

A. Not as I read the text and as quoted in my testimony on the subject. The quotation reads:

"The tail is made with ribs like those of the wings and furthermore, it can have below, and even above, a vertical rudder Z which can
1266 be seen on Sheet XII. *These two rudders are operated from the inside.* * * * When the aeroplane has a vertical rudder it is fixed in the same plane as the rear wheel, and is manœuvred in conjunction with it." The passage just quoted taken together with the drawing in the publication clearly discloses a vertical rudder turnable about a vertical pivot at its forward end and intended for steering to right and left.

XQ53. And the translation, in the last sentence says: "rear wheel steered with the vertical rudder for landing purposes." Is not this the only

statement in the translation of the time when, 1267
or the use for which, the vertical rudder was to be operated? In other words, if there is any passage in the translation which states that the vertical rudder Z is to be used were the machine in flight, please quote that passage?

A. The underscored sentence in my last answer occurs in a paragraph of the translation which makes no reference to the rear wheel or landing purposes. The succeeding sentence states that the vertical rudder is moved in conjunction with the rear wheel, but makes no reference to landing. As the use of a vertical rudder for
steering to right and left was so very well 1268
known in the art at the time of Ader's experiment, no further description is necessary than the above taken together with the drawings to make obvious to one skilled in the art, that the rudder in question can be used for steering in flight even though movable in conjunction with the rear wheel.

XQ54. But you have argued the proposition with me. I merely asked you to quote the passage in the translation, if there is any, which states that the rear vertical rudder was to be used while the machine was in flight? If there is
such a passage, quote it, and if not, kindly say 1269
so.

A. I do not observe any passage which specifically states that the vertical rudder is to be used while the machine is in flight, but I have quoted passages which state that the vertical rudder is to be operated, without any reference to the time or place of such use, and to one skilled in the art it is obvious from the construction and nature of the vertical rudder as disclosed in the text and drawings that it can be used in flight as well as when landing. The mere fact of its turning in conjunction with the rear wheel

1270 does not in the least impair its functioning as a vertical rudder for steering in flight.

By Mr. Toulmin: All of the answer after the word "flight," first appearing, is objected to as volunteered and non-responsive.

XQ55. You have stated that the "forward edge of one wing" of the Ader illustrated machine may be raised. But is it not true that only the forearm, A, B is described as the part which is to be raised or lowered, and not the forward edge as a whole?

1271 A. But the preceding testimony makes my meaning clear in the more detailed and specific passage, which reads: "second, the bending of the wing at the elbow whereby its forearm is raised or lowered, thus raising or lowering the front margin of the outer part of the wing." This I take to be an affirmative reply to your question.

XQ56. And this up and down movement of the forearm A, B is on a longitudinal axis, is it not?

A. Not necessarily, for the forearm is pivoted in such manner that it can be bent in any direction; either fore and aft or up and down, or to any inter-
1272 mediate position.

XQ57. Does your last answer state your conclusions from the drawings and text?

A. It states my conclusions from the text at least, whether or not the drawings be considered. Thus one passage of the text reads: "Aside from this the elbow U turns on itself, and consequently carries with it the forearm, the hand and its fingers. This action is for the purpose of *warping the tip of the wing, so as to destroy or re-establish equilibrium in the wings.*" Another passage describes a flexing movement in which "the forearm folds on

the arm." These passages show that the forearm 1273
can be moved in any direction up and down or sidewise.

XQ58. I notice you have substituted the words "and consequently" for the word "necessarily," in your quotation from the translation exhibit in evidence. Did you do that to correct what you regarded as an error or mistake in the translation?

A. I did it to correct what seems to be an oversight in the translation of the French expression *"et par suite,"* in which the translator omitted the word "and" entirely, thus making the version at this point extremely obscure.

XQ59. Is not the forearm A, B shown raised with 1274
reference to the arm proper, on a horizontal axis in Figs. 32 and 34, and shown lower on such axis in Fig. 36 of the Ader drawing in evidence?

A. Apparently it is, but it would show the same if it were also rotated about itself for warping purposes as explained in the passage cited in my answer to XQ57.

XQ60. And the fingers D^1, D^2, D^3 and D^4 are fastened to the forearm A, B, are they not?

A. The text states that "the fingers are articulated to the hand."

XQ61. And the hand is connected to the forearm, is it not? 1275

A. It is articulated to the forearm.

XQ62. Then if the forearm is lifted up or pressed down, the hand and fingers will move bodily up and down with the forearm, will they not?

A. Not necessarily; since the forearm is capable of rotating about itself, it can raise the articulated or basal ends of the fingers without raising the tips or outward extremities of the fingers, thus causing the wing tip to change its angle of incidence.

XQ63. But as Fig. 1, plate XIV of the Ader drawings shows the joint between the forearm A, 1276 B, the thumb P and fingers D^1, D^2, D^3 and D^4 to be a vertical joint, will not the fingers therefore bodily rise and fall with any upward or downward movement of the forearm?

A. Not if the forearm rotates about itself while rising or falling; I mean rotation about its length as an axis.

By Mr. Toulmin: I have not concluded the cross examination and will do so to-morrow if I can remain in the city, or will have the same done by some substitute counsel. I received a telegram respecting sudden illness in my family and may have to leave for home
1277 to-night. If I do not return in the morning to attend, or send no substitute counsel, then counsel for defendants may proceed with the redirect examination of Dr. Zahm, and after that may call some other witness, unless I ask for a continuance by wire or otherwise.

Adjourned at 4:15 P. M. to to-morrow, Nov. 11th, at 10:30 A. M.

New York, N. Y., Nov. 11, 1911.

1278 Met pursuant to adjournment.

Present—E. R. Newell for Defendants; and
Pliny Williamson, one of the Solicitors for Complainant.

Mr. Williamson states that Mr. Toulmin's mother is very ill and probably dying, which necessitated Mr. Toulmin's going west. Mr. Newell states that Mr. Toulmin told him about this yesterday and Mr. Newell told him that he would adjourn the testimony until after the Buffalo hearing on the 14th if Mr. Toulmin wished to, but Mr. Toulmin

stated that he did not wish this done, and 1279
put on the record the statement appearing
at the close of yesterday's testimony. Mr.
Newell therefore has Dr. Zahm here ready
for the completion of his testimony, and
another witness ready to go on to-day, and
still another for Monday. Mr. Williamson
does not feel authorized to state that the
cross examination of Dr. Zahm is completed
and is of the opinion that it would save con-
siderable time if he did not proceed with the
cross examination of Dr. Zahm this morning
but allowed that to stand over until Mr.
Toulmin or his partner comes from Ohio. 1280

It is therefore agreed that Mr. Newell may
put on Mr. Spratt to-day for his direct ex-
amination and put on Mr. Curtiss on Mon-
day, and if his direct examination is
finished on Monday, his cross examination
must be finished by Tuesday night if the
Buffalo hearing is adjourned, and if not,
then on Wednesday. The cross examination
of Mr. Spratt and the cross examination of
Dr. Zahm are adjourned until after Mr.
Curtiss's testimony is completed, and they
will be presented for further examination
after Mr. Curtiss's testimony is finished, it 1281
being the understanding at this time that
all the testimony of both Mr. Spratt and Dr.
Zahm will be completed within the coming
week unless unforeseen contingencies arise.

GEORGE A. SPRATT, a witness called on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age and residence.

A. George A. Spratt; age, 41; residence, Coatesville, Pennsylvania.

1282 Q2. How long have you been interested in aerodynamics?

A. Since 1896.

Q3. Do you know Orville and Wilbur Wright?

A. Yes, sir.

Q4. About how long have you known them?

A. Since 1901.

Q5. Do you know Wilbur Wright's handwriting?

A. Yes, sir.

Q6. I show you here three letters, and ask you if you recognize them, and if so, please state who they were written to and in whose hand-writing
1283 they are?

A. They are written to me by Wilbur Wright in his own hand-writing.

> The three letters referred to are introduced in evidence, and requested to be marked as Defendant's Exhibits "Wright Letters" dated "Dec. 15, 1901," "May 24, 1903" and "Oct. 18. 1904."

Q7. Were you with Orville and Wilbur Wright at their camp at Kitty Hawk, N. C., at the times when they were conducting experiments in 1901 and 1902?

1284 A. Yes, sir.

Q8. Did you see them glide in their gliding machines at those times?

A. Yes, sir.

Q9. Were the main supporting surfaces of those machines flat or curved?

A. They were curved.

Q10. All of them?

A. Yes, sir.

Q11. What was the shape of this curve from front to rear?

A. They were parabolic.

Q12. Where was the deepest part of the curve? 1285

A. About one-sixth or one-fifth of the distance from the front.

Q13. Have you examined a copy of the drawings of the patent in suit No. 821,393?

A. Yes, sir.

Q14. What can you say as to the efficiency and controlability of a machine built the same as shown in the drawings of the patent in suit but with perfectly flat main supporting surfaces?

A. It would be very much less efficient than with the surface used by them and it would be harder to control. I don't think it would be a practical machine used as a glider. 1286

Q15. With relation to the travel of the center of pressure, is such a curved surface as the Wrights used better or not than a flat surface?

A. I think it is better.

Q16. On a perfectly flat surface where is the center of pressure at small angles, say two or three degrees, that is, is it toward the front or toward the rear?

A. It is toward the front.

Q17. As the angle of incidence increases, how does the center of pressure travel?

A. It travels toward the center of the plane, backwards. 1287

Q18. Do you or do you not consider that a machine built exactly according to the drawings of the patent in suit would be a dangerous machine to use as a glider?

A. I do.

Q19. You have said that you have seen the Wrights glide in their machines. Have you seen them gliding and losing lateral equilibrium and warping the surfaces and restoring the lateral balance?

A. Yes, sir.

1288 Q20. When in flight in the glider, could they warp the surfaces sufficiently to cause that margin whose angle of incidence was decreased, to become negative?

A. No, sir.

Q21. In order to make the front horizontal rudder of the patented machine properly control it, must or must not its size and location be changed for different curvatures of main surfaces?

A. Its size and location must be changed.

Q22. You saw the Wrights glide many times in their glider?

A. Yes, sir.

1289 Q23. Did you ask them for permission to come to their camp, or did they invite you to come of their own accord?

A. The invitation was given to me by Mr. Chanute.

Q24. Did the Wrights, or either of them, ever give you invitations themselves?

A. Yes, sir.

Q25. Did you go down there more than once on their invitation?

A. Yes, sir.

Q26. In their gliders, when the machine was gliding and became tilted laterally, did the machine move straight ahead so tilted, or did it move
1290 off to one side?

A. It moved off to one side.

Q27. Toward which side?

A. Toward the low side.

According to the agreement this morning, the testimony of Mr. Spratt is adjourned until further notice for cross examination.

At the request of Mr. Mahan, representing the complainant, it is agreed that any objections to the foregoing evidence in this deposition may be taken by Mr. Toulmin or

Mr. Reed whenever one of them next ap- 1291
pears.

Adjourned at 3 P. M. to 10:30 A. M., Monday, Nov. 13th.

November 17, 1911 (afternoon).

Cross examination of Mr. Spratt by Mr. Toulmin:

XQ28. Have you not seen the Wright gliders, and Wright motor aeroplane fly with so little inclination of the wings to the line of flight, that the angle of incidence was not more than two or three degrees?

A. I cannot tell the exact angle of incidence. 1292

XQ29. What was the angular range of movement of the tips of the Wright gliders you saw in 1901, 1902 and 1903?

A. Well I would suppose, considering one wing tip alone, it could be changed to through about six or eight degrees or thereabouts, although I am not sure as to this.

XQ30. What was the duration in time of the longest flight of the Wright glider you witnessed?

A. I would have to consult the records that I happen to have of such things.

XQ31. Then you cannot state from memory?

A. I would not like to state this from memory. 1293

XQ32. Can you state what was the speed of the wind during the longest flight you witnessed?

A. I do not remember that distinctly.

XQ33. Can you state approximately what was the speed of the wind during the longest flight you witnessed?

A. If I remember rightly, they generally flew when the anomometer recorded somewhere about twenty miles.

XQ34. You say generally. Do you recall any glides or flights made when the wind was as much as thirty miles an hour?

1294 A. I do not recall any such glides.

XQ35. Do you recall any when the speed of the wind was 25 miles an hour?

A. They were points that I only took a secondary interest in.

Redirect examination by Mr. Newell.

RDQ36. How high above the plain was the high hill from which the Wrights made their glide?

A. It was supposed to be from 80 to 115 feet high, depending upon the condition in which the last storm left it. It was a pile of shifting sand.

RDQ37. Did you ever see their gliding machine
1295 start out on a glide and come to earth within a comparatively few feet of its starting point?

A. This often occurred.

RDQ38. Did you ever see it rear up into the air?

A. Yes, sir.

RDQ39. Did you ever see it turn downward suddenly and compel an alighting on the ground or on the face of the slope?

A. Yes, sir.

RDQ40. Did you ever see their machine stick one wing in the sand and slew around in alighting?

1296 A. Yes, sir. This often occurred.

RDQ41. Did you ever hear the Wrights say anything about someone having attempted to duplicate their machine. If so, please state about what was said?

A. I believe Mr. Chanute communicated a description of the Wright glider to some man in France or Germany who attempted to imitate the machine and failed to obtain the desired results through not correctly duplicating the curve. I do not remember any direct statements, but his failure was amusing to the Wrights, and was so pronounced upon by the Wrights. 1297

By Mr. Toulmin: As the answer appears to be hearsay and gossip, it is objected to as incompetent, though it does not appear to be material. Such objection is made once for all.

RDQ42. Were you present when this matter was mentioned by the Wrights and when they were amused at it, as you say?

A. Yes, sir.

RDQ43. Did they make any particular comment on it, except to laugh at it? 1298

A. I do not recall any such remarks, but the reason was well known to all of us.

RDQ44. Mr. Chanute had been down at their camp and seen their glider, had he not?

A. Yes, sir.

RDQ45. Did you often see their glider land sidewise?

A. Never exactly sidewise, that is not end on. It often landed very markedly sideways. That's as near as I would like to state it.

RDQ46. Do you mean that when it lit it tended to slide more or less sidewise? 1299

A. It lit sidewise and tended to slide in the direction of its flight.

RDQ47. That is in the direction of the length of the main supporting surfaces?

A. It lit in such a way that the strains upon the machine were more or less from one wing tip towards the other.

RDQ48. These results which you have mentioned above were observed by you in the use of the glider which had the rear rudder automatic-

1300 ally moved simultaneously with the warping of the wings?

Objected to as leading.

A. They were more pronounced upon the machine without the rear vertical vane. If I recall correctly, such landing would occasionally occur with the machine described in the question. Such a landing might occur in any machine.

RDQ49. Then even with such machine the desired results were not always obtained. Is that correct?

1301 A. This is correct.

Recross examination by Mr. Toulmin:

RXQ50. Are you now doing, do you hereafter expect to do, or have you in the past done any work or experimenting for Glenn H. Curtiss or the Herring-Curtiss Company, or the Curtiss Exhibition Company?

A. I am now doing no experimental work for any of those companies or Glenn H. Curtiss mentioned; I have done none for them; and I have no expectation of doing so.

RXQ51. Answer the same question as to
1302 advising them on scientific questions, or furnishing them with information regarding aeroplane construction, or tables of pressure?

A. I have had no business dealings of this nature direct with such companies or with Mr. Curtiss. I met Mr. Curtiss for the first time in this office a few days ago.

GEO. A. SPRATT.

New York, N. Y., Nov. 13, 1911. 1303

Met pursuant to adjournment.

Present—Mr. MILTON A. FISCHER, from Williamson & Smith's office, representing Complainant.

EMERSON R. NEWELL, for Defendants.

GLENN H. CURTISS, a witness heretofore introduced on behalf of defendants, being recalled, testifies as follows in answer to questions by Mr. Newell:

Q1. Are you the Glenn H. Curtiss who has heretofore testified in behalf of defendants? 1304

A. I am.

Q2. Complainant's counsel has introduced in the record Complainant's Exhibit "Curtiss-Hamilton complaint" and the "Curtiss Affidavit March 18, 1910," from which he apparently contends that the statements made in said affidavit are incorrect, or some of them. Please state whether or not in that affidavit you intended to state the facts as you understood them from the affidavit of Mr. Knabenshue, in reply to which your affidavit was drawn?

By Mr. Fischer: I object to this as the affidavit of Mr. Curtiss speaks for itself as 1305
being clear and unambiguous.

A. In the affidavit referred to, I intended to and believe I did, state the facts in reply to the affidavit of Mr. Knabenshue.

Q3. If you have a copy of the lease under which Mr. Hamilton was flying, will you please produce it?

A. This is a copy of the lease made with Charles K. Hamilton in November, 1909.

Counsel for defendants herewith introduces said copy, and requests that it be

1312 place named San Diego, as I heard before I left California that some of the citizens of San Diego were desirous of securing an aviator to fly there. I know now that Mr. Hamilton did fly at San Diego.

Q10. In your affidavit you stated "Mr. Knabenshue apparently tries to give the impression that Hamilton was flying for me or the defendant company. This is not so." You had just stated that Hamilton was flying a leased machine. Please state what you meant by the words "flying for me or the defendant Company?"

A. Mr. Knabenshue's affidavit would indicate
1313 that Mr. Hamilton was an employee of the Company or of myself. I wanted to make it plain that this was not a fact and that neither I nor the company was responsible for Mr. Hamilton's actions, and that Mr. Hamilton was operating the aeroplane in his own behalf.

Q11. If I understand you correctly, the lease to Mr. Willard was after the Los Angeles meet. Is that correct, or at least did not cover the Los Angeles meet?

A. I do not recall the date on which the lease was made, but I think it was not made until after the Los Angeles meet had closed. At any rate, Mr.
1314 Willard did not come into possession of an aeroplane from me until after the meet had closed, and I think it was some weeks after before he made an exhibition flight with such a machine. During the Los Angeles meet Mr. Willard flew an aeroplane which I believe was owned by a Mr. Stroble, who had purchased it of the Aeronautic Society.

Q12. In your affidavit you stated "Hamilton and Willard fill their engagements for their own benefit," and "It is not true that the flights and proceeds of Messrs. Hamilton and Willard since the

California meet were on my behalf or on behalf of 1315
my Company." Will you please explain what you meant by "for their own benefit" and "on my behalf?"

A. I meant that Messrs. Hamilton and Willard were not agents or employees of myself or the Herring-Curtiss Company. They had a right to make engagements to fly the machine which they had leased from me, and to fix their price for such flights, and that they were entitled to all of the money received. As the lease itself will show, the amount which Mr. Hamilton was to pay for the use of the machine was a sum equal to a percentage of
what he earned with the machine after certain ex- 1316
penses had been deducted. Mr. Willard leased a machine under a very similar arrangement, and it is evident when the facts are known that neither Mr. Hamilton nor Mr. Willard were making flights on behalf of either me or the Herring-Curtiss Company.

> Mr. Fischer objects to the latter part of the witness's answer beginning with "and it is evident" and running to the end of the answer, as it states conclusions of the witness irrelevant and uncalled for by the question. 1317

Q13. Hamilton and Willard could make engagements, fill them and collect the proceeds, without saying anything to you except afterwards to pay over the amount stipulated as rent for the machine?

A. That is what they did and that is the way in which the lease was interpreted.

Q14. In Complainant's Exhibit "Curtiss-Hamilton Complaint," there is specified "a written contract made between the parties hereto, dated the 17th day of November, 1909." Is that the lease

1318 under that date which has been introduced as Defendant's Exhibit "Hamilton Lease?"

A. Yes, that is the lease I referred to.

> Mr. Fischer objects to all questions which tend to bring forth answers explaining the affidavit of Mr. Curtiss, or tending to interpret the leases between Mr. Curtiss and Mr. Hamilton and Mr. Curtiss and Mr. Willard. The affidavit was made to meet that of Mr. Knabenshue and to answer it fully and should have done so. These explanations coming at a later date are irrelevant and not in order. The above leases contain the full
> 1319 contract between the parties and evidence tending to interpret them is not admissible.

Recess for Lunch.

New York, N. Y., Nov. 15, 1911.

Met pursuant to agreement at 10.30 A. M.

Present—H. A. Toulmin, Esq., for Complainant;
and
E. R. Newell, Esq., for Defendants.

No testimony was taken yesterday on account of
1320 the motion for extension in Buffalo.

Cross examination of Mr. Curtiss by Mr. Toulmin:

> By Mr. Toulmin: Without waiving the objections to the direct testimony of Mr. Curtiss, the cross examination is proceeded with.

XQ15. You made this affidavit of March 18, 1910 in answer to the affidavit of Mr. Knabenshue of March 17, 1910 and in opposition to a motion by complainant to increase the bond defendants were then under to protect complainant from loss by infringement, did you not?

A. I do not recall that I knew at the time just 1321
the purpose of the affidavit, excepting that it was to correct the mistakes or misrepresentations of Mr. Knabenshue's affidavit.

XQ16. And do you now testify that when you made your affidavit of March 18, 1910 you did not know it was in opposition to a motion to increase the bond?

A. I testify that I do not remember whether I knew this at the time or not.

XQ17. And you made such affidavit to show that you or your company, the Herring-Curtiss Company, had no money interests in the proceeds derived from flights by Hamilton and Willard, or 1322
either of them?

> By Mr. Newell: Objected to as immaterial, for the affidavit speaks for itself as to what was stated. The affidavit distinctly states that Hamilton was flying a leased machine.

A. I made the affidavit under the direction of our attorney and simply stated the facts as I knew them.

XQ18. Question repeated as it has not been answered.

A. I repeat that I do not know of a specific pur- 1323
pose for the affidavit other than to answer Mr. Knabenshue and deny or correct some of the statements he made.

XQ19. But my question was an is whether you made that affidavit to show that you or your Company had no money interest in the proceeds of the flights of either Hamilton or Willard. Please answer that.

> By Mr. Newell: Question objected to as immaterial. The statements made in the affidavit is the only thing under considera-

1324 tion, and the witness has already answered this question in effect. The affidavit does not state what the question seems to imply.

A. I have answered the question to the best of my ability.

XQ20. And you swore to the petition in your suit against Hamilton, which petition is in evidence herein, in an effort to recover 60% of the net proceeds of Hamilton's flights specified in the lease of November 17, 1909, an exhibit herein, did you not?

A. I swore to the petition in a suit to recover some $6,000 owed by Hamilton as rental for the
1325 machine he was using.

XQ21. And your statements in said petition and your testimony given in Court in the trial of that case resulted in your getting a verdict against Hamilton for some $6,000, did they not?

A. I believe we got a verdict in our favor. I was not at the trial, so that the verdict could not be referred to as a result of my testimony.

XQ22. Did you testify by deposition or otherwise in that case in support of said petition to which you have sworn when signing it?

A. I do not recall having made any further deposition or affidavit in that case.

1326 XQ23. And a part of the judgment obtained against Hamilton in that action was made up of 60% of the net proceeds derived from the $2,500 gross which Hamilton received for the flight exhibitions he gave for that amount as stated in the affidavit of Knabenshue? Knabenshue names Santiago instead of San Diego, as stated by you in your answer 9 in this deposition, there being a difference in spelling of the name of this place.

Defendant's counsel objects to the question. The judgment is the best evidence of

what it shows. Knabenshue's affidavit, as 1327
taken from the printed transcript of record, states Santiago, and it is assumed that he meant what he said, and that if he had meant San Diego he would have said it. It is not a mere question of difference in spelling.

By Mr. Toulmin: As in his direct testimony herein Mr. Curtiss has not shown that there was more than one exhibition given by Hamilton for which he received $2,500, in the State of California, it is clear that the sum of $2,500 is the substance of the
matter and not the place, or the mode of 1328
spelling the name of the place.

A. It is not.

XQ24. Do you mean that 60% of the net of the $2,500 was not sued for and included in the action against Hamilton?

By Mr. Newell: This line of examination is objected to as improper cross examination, and is calling for secondary evidence. The witness has already stated that he doesn't recollect the details, especially as he was not present at the trial. The record
of the case, according to the Court records, 1329
is the best evidence.

A. That is what I mean.

XQ25. And was 60% of the net of the $4,000 gross received by Hamilton for his engagement at Fresno, California, as stated in the affidavit of Knabenshue, included or not included in the action against Hamilton and the resulting judgment?

A. It was not.

By Mr. Toulmin: Notice is hereby given that complainant reserves the right to fur-

1330 ther cross examine Mr. Curtiss on this general subject concerning his affidavit of March 18, 1910 and his sworn petition in the action against Hamilton, which petition and affidavit are in evidence herein, as also concerning Defendant's Exhibit "Hamilton Lease," in the presence of the Court or Judge at the trial of this case on final hearing. The Circuit Court is here referred to.

By Mr. Newell: By stipulation appearing at the beginning of the November 11th session Mr. Curtiss' cross examination must
1331 be completed "on Wednesday," which is today, as the Buffalo hearing yesterday was not adjourned. In view of this stipulation counsel understands that no further cross examination is allowed.

By Mr. Toulmin: It is true that such a statement appears on the record under date of November 11, 1911, but it was made in the absence of myself and while I was in Ohio because of illness in my family. It was an unjust limitation upon the right of cross examination and ought not to be insisted upon. But as it is of record, it will
1332 be called to the attention of the Court should the right above reserved be exercised at the hearing.

By Mr. Newell: I have heretofore understood that you would abide by stipulations put in the record. If not, please say so in order that I may be fully warned as to whether or not I can rely on stipulations.

By Mr. Toulmin: It seems superfluous to say that the stipulations made on behalf of complainant will not be observed, but it is manifest that to limit the cross examina-

tion of Mr. Curtiss to one particular day, 1333
under the circumstances of the absence of myself, the only active counsel in the case, was in the nature of taking an advantage, whether so intended or not. This is not the case of an ordinary stipulation made between the active counsel in the case.

By Mr. Newell: Mr. Williamson appeared on November 11th representing the complainant, and stated that he had expected Mr. Reed, Mr. Toulmin's partner, to be present, and Mr. Williamson said he did not wish to go ahead with the cross examination of Dr. Zahm as he did not feel as 1334
competent to do so as Mr. Toulmin. After discussing the matter for over an hour, we agreed on the stipulation which appears of record, and the direct testimony of Messrs. Spratt and Curtiss were taken, and their cross examination put off until now, all in exact accordance with the stipulation, in order that no advantage of the absence of Mr. Toulmin personally should be taken. Now counsel for complainant apparently desires to disregard a deliberate agreement put on the record by his representative.

By Mr. Toulmin: My statement last made 1335
would seem sufficient in this whole matter.

XQ26. Since your first deposition in this case was closed, it has been testified by Dr. A. F. Zahm, a witness on behalf of defendants, that you have filed in the U. S. Patent Office an application for a patent on an apparatus whose object is to prevent the unequal angles of incidence of ailerons from causing, by their difference in head resistance, a turning of aeroplanes on their vertical axis. Is it true that you have filed such an application?

1336 By Mr. Newell: Objected to as obviously improper cross examination. This matter was not touched on in the direct examination, which only went into the matter of the affidavit. Furthermore the question does not state the facts.

The witness is therefore instructed that he need not answer the question.

By Mr. Toulmin: The rule invoked in the objection does not apply where the witness is a party to the cause. For this reason an answer is insisted upon, and the witness is asked whether or not he will answer.

1337 By Mr. Newell: Instruction to the witness is repeated.

A. As instructed by counsel, I refuse to answer.

XQ27. Well, did you in fact file an application for a patent in your own name as inventor on such an apparatus?

Same instructions and objection.

A. For some reason which is beyond my understanding, my counsel advises me not to answer the question and therefore I refuse to answer.

XQ28. Dr. Zahm has also testified that there is now pending before the Patent Office an inter-
1338 ference proceeding in which such an application filed by you and an application on a similar apparatus filed by himself, are involved. Is that correct?

Same objection and instructions.

A. I will make no answer on the subject.

XQ29. Are you willing to produce to be offered in evidence herein a Patent Office certified copy of the file wrapper and contents with prints of the drawings, of your said application if complainant pays the cost of such a copy? 1339

By Mr. Newell: The witness is instructed that this is unnecessary, especially as this matter has been covered by an agreement by me in the session of October 27th. The witness is therefore instructed that he need not answer the question.

A. I refuse to answer.

By Mr. Toulmin: The cross examination is closed subject to the reserved right above indicated on the record.

By Mr. Newell: I object to any such alleged right in view of the stipulation, in order that it may be clear that I do not acquiesce. I object to having stipulations of record disregarded. 1340

By Mr. Toulmin: The statements already made by me as to the circumstances under which the limitation as to Mr. Curtiss' cross examination was made with Mr. Williamson would seem sufficient.

Redirect examination by Mr. Newell:

RDQ30. The answers which you gave in your cross examination in regard to the Hamilton suit are as to your recollection of the matter at the present time? 1341

A. Of course this must necessarily be so as I did not have the papers and records regarding which I was questioned before me, but I believe I am correct.

G. H. CURTISS.

Adjourned for recess at 12:30.

1342 Resumed after Lunch.

Cross examination of Dr. Zahm by Mr. Toulmin:

As Mr. Spratt is not in town at present, the cross examination of Dr. Zahm, interrupted on Friday, is continued.

XQ64. What success, if any, did Marriott have with the apparatus shown in his patent to which you have referred?

A. I have not inquired and I do not know whether said apparatus was ever constructed.

XQ65. What success, if any, did Harte have with the apparatus shown in his British patent
1343 to which you have referred?

A. I have not inquired and do not know.

XQ66. When did you first learn of this Harte invention as shown in this British patent?

A. I do not remember the exact date, but it was during the present year, and since I became engaged in the present suit.

XQ67. What, if any, success did Johnston have with the apparatus shown in his patent, to which you have referred?

A. I have not inquired and do not know whether he ever built such apparatus.

XQ68. And when did you first learn of the In-
1344 vention disclosed in this patent to Johnston?

A. Since I became engaged in the present suit.

XQ69. What success, if any, did Boulton have with the apparatus disclosed in his British patent of 1868, to which you have also referred?

A. I am not aware that Boulton himself ever constructed such apparatus, but I have seen the controlling device disclosed in the Boulton patent applied successfully by Mr. Curtiss for controlling the lateral equilibrium of an aeroplane, as stated in my direct testimony.

XQ70. But that was since the institution of this 1345
suit and a part of your preparation for testifying herein, was it not?

A. It was since the institution of this suit, and I noted on paper the construction and operation of the Boulton device employed by Mr. Curtiss, so that I could accurately report my observations, if required in the present suit.

XQ71. Then such observations were a part of your preparation for testifying herein?

A. Such observations constitute a part of my exact knowledge of aviation appliances and principles, any or all of which may be regarded as a
preparation for giving testimony regarding the con- 1346
struction and operation of aeroplanes.

XQ72. And such observations of the alleged experiment with the Boulton appliance were after you had read the Wright patent on which this suit is based, were they not?

A. Substantially speaking, no; my first careful and critical reading of the patent in suit was made subsequent to the observations in question, though I had a long time previously glanced over the patent without making a careful or critical study of it.

XQ73. What success, if any, did Crepar have with the apparatus shown in his U. S. patent, to
which you have alluded? 1347

A. I have not inquired and I do not know whether he ever constructed such apparatus.

XQ74. And was your first knowledge of this Crepar patent after you began to prepare yourself to testify in this case?

A. As I remember, I read the patent for the first time since I became engaged in the present suit.

XQ75. What success, if any, did Mouillard have with the apparatus as shown in his U. S. patent, to which you have also referred?

1348 A. Mouillard made some brief flights with a glider of substantially the character of the one disclosed in his patent, in Africa, as I remember, but I have not inquired and do not know positively that he ever constructed an apparatus exactly like the one disclosed in the patent.

XQ76. Do you not know, as a matter of fact, that the apparatus he tested in Africa did not have the flaps or extended portions marked J and J′ and the operating cords therefor, as shown in the Mouillard patent?

A. On the contrary, as I remember the account given by Mouillard himself, he provided some
1349 means for warping the wings in flight, though I cannot say that the mechanism for accomplishing this was identical with that disclosed in the Mouillard patent.

XQ77. You do not seem to be certain as to just how Mouillard did construct his apparatus in Africa. But I will ask you this further question; whether he did not abandon his efforts after a trial or two, in one of which he was injured, and did he not finally die after going to Cairo without ever constructing any further apparatus?

A. My uncertainty is due to not having read Mouillard's account of his experiments for a very
1350 long time, but not due to any uncertainty as to the fact that in such accounts he strongly advocated wing-warping, and that he actually constructed and operated one or more simple gliders. I remember also that he did not abandon either the wing-warping principle or the actual designing of gliders after such accident. He was, however, as he himself states, too old a man to make such flights. It is certain that the Mouillard patent under discussion was applied for after the date of his earlier flights and his accident.

XQ78. Do you rely upon the Mouillard patent in evidence for authority for your statement that he employed or knew of what you term the wing-warping principle? 1351

A. He disclosed and advocated the wing-warping principle, as I remember, in his published writings previous to the date of his patent, though as stated in my direct testimony this patent also discloses a glider having flexible rear marginal wing tips provided with suitable control cords by which the pilot can change their angle of incidence as desired, thus enabling him to exert a balancing torque about the longitudinal axis, or to turn the machine about the vertical axis for purposes of steering to 1325
right or left. Fig. 10 of the patent actually shows the wing warped so as to change the angle of incidence of its outer rear margin.

XQ79. Can you give the names of the publications containing the writings of Mouillard wherein he refers to wing-warping?

A. I do not recall the names of all his published accounts, but in L'Empire de l'Air, as I remember, he proposes wing-warping and describes a number of his earlier gliders.

XQ80. And does his patent 582,757, to which you have referred, state that the wings are to be warped, and if so quote the language? 1353

A. This question seems to me substantially the same as XQ45, and I would answer it in the words of my reply to that question.

XQ81. And do you say that Mouillard met with success or failure from a practical standpoint, seeing that after his experiments on his farm in Africa he went to Cairo and thereafter built no more apparatus and died, without leaving any of his apparatus in use by others?

A. From the practical standpoint of advancing the science and art of aviation, I should say that he achieved distinguished success, as did Henson, 1354 the original inventor of the aeroplane, and every subsequent inventor and scientist who contributed an important device or principle to the general fund of knowledge which is essential to or useful in practical aviation. As I remember, he continued his studies and writings after leaving his farm and after he was too old to operate aerial gliders and too poor to pay for their construction. It was during this period of retirement, as I remember, that he applied for the patent disclosing wing-warping mechanism, when, as you say, he died without leaving any of his apparatus in use by others.

1355 XQ82. By the expression "From the practical standpoint" you mean that he experimented and wrote and died, without leaving behind any of his apparatus in use? Is not this substantially correct?

A. No, the practical value of his work in question was to disclose and widely disseminate the principle of wing-warping, so that it might be available to anyone who wished to use it.

XQ83. And so you still say that his writings disclose and state "wing-warping?"

A. They disclose wing-warping, but the exact term "wing-warping" is not used in French, I believe.

1356 XQ84. And do you also say that the apparatus he experimented with in Africa had wings with the warping feature? I ask this question, and all others, with reference to any alleged foreign experiments or uses, not because they are available to a defendant under our statute, but to test the quality of your information. With this information please answer this question.

A. I can easily report exactly what Mouillard stated in L'Empire de l'Air if you wish it, but in answering your questions thus far I have been replying from memory and without having read Mouillard's book for more than a year. Thus an-

swering your question from memory, Mouillard, 1357
as I recollect, first used gliders without mechanism for warping the wings, but disclosed the wing-warping principle and proposed to employ it in a glider previous to the date of his patent application.

XQ85. Well do you say that any of his experimental machines tested in Africa had or did not have the wing-warping feature?

A. I would not say positively without first consulting his writings.

XQ86. With what success, if any, did Mattullath meet, from a practical standpoint, seeing that in
the copy of his specification put in evidence herein 1358
and which you stated you assisted him in drafting, contains such expressions as "I believe I can fly upon an angle of less than three degrees;" "I will be able to build a structure within the limit of the weight I will be restricted to;" "I contemplate to build it," etc., showing that he had not built his apparatus?

A. My testimony states that "I assisted him in making a patent application," but this assistance was rendered after the date of filing. I had no hand in the actual drafting and no knowledge of its wording till after it was done. Now answering
your question directly, I would say that Mr. Mat- 1359
tullath's practical success consisted in part in disclosing to many engineers and scientists in the United States the now commonly used and very important three-torque system of control, both in principle and in a specific contrivance disclosed in his patent application; in part also in prosecuting or instigating important researches in aerodynamics and structural design as preliminary to the actual building of the aeroplane disclosed in his patent application.

Adjourned at 4:35 P. M. to to-morrow, Nov. 16th, at 10:30 A. M.

1260 New York, N. Y., Nov. 16, 1911.

Met pursuant to adjournment, at 10.30 A. M.

Present—Counsel as before.

Cross examination continued:

XQ87. In your last answer you speak of alleged investigations of Mattullath "as preliminary to the actual building of the aeroplane disclosed in his patent application." Was the apparatus disclosed in said application ever actually constructed and used in flight?

A. It was never used in flight and never con-
1361 structed in full, as Mr. Mattullath died suddenly toward the close of his preliminary experiments, as stated in my direct testimony.

XQ88. You have spoken of other engineers than yourself who were associated with Mr. Mattullath during that time. Will you please give the names and addresses of as many of them as you now recall?

A. Mr. Jacob Schineller and Mr. Laub, both of Pittsburgh, were in frequent consultation with him, several times in my presence; Professor Coolidge of the University of Wisconsin, and Professor Thurston of Cornell University, Professor Harvard D.
1362 Williams, formerly of the Bureau of Steam Engineering of the Navy Department, were consulted but not directly associated with Mr. Mattullath, as I learned from him. There were several others whose names and addresses I do not exactly recall.

XQ89. In answering XQ86 you say the assistance you rendered Mattullath respecting his patent application was after the filing date. Did you in fact ever see a complete and full copy of the specification and drawings and also the claims, as they were filed in the Patent Office, until you saw the

Zahm

certified copy offered in evidence in this case in 1363
connection with your testimony?

A. Yes, I spent many hours with Mr. Mattullath in discussing the patent application and explaining the nature of the invention, which explanation was in part written out for the information of the patent examiner.

XQ90. And as the application was filed January 8, 1900, when was it you say you first saw such a copy of the application and drawings?

A. As nearly as I can remember, it was in the Winter of 1900.

XQ91. And when did Mr. Mattullath die?

A. In December, 1902. 1364

XQ92. In the exhibit of his specification in evidence it is stated to be the fact that "no successful flying machine of this character has ever been constructed." Is that statement true in point of fact, or do you differ with Mr. Mattullath over whose oath such statement appears?

A. In order to make clear Mr. Mattullath's meaning in that statement, I will quote the sentence preceding it: "The object of my invention is to construct a flying machine capable of commercial application for the transportation of goods and passengers." Now, answering your question directly, I am not of the opinion that the flying ma- 1365
chines preceding the date of Mattullath's application were incapable of development to a capability of commercial application for the transportation of goods and passengers; but at that date, in my opinion, the development had not been practically achieved, and has not yet been achieved in any aeroplane, seeing that they have not come into practical use for the commercial transportation of goods and passengers.

XQ93. In your last answer you couple the statement in Mattullath's specification that no success-

1366 ful flying machine of this character has ever been constructed with the object of his invention, as stated in the preceding paragraph, instead of coupling such statement with what he stated in the same paragraph in which it occurs, which statement refers to "the possibility of dynamic flight upon the principle of aeroplane propelled at an angle to the direction of flight." Do you not think the term "machine at this character" has reference, not to the character of use, but to aeroplane machines?

A. In order to make my answer clear to the Court, I will quote the whole passage containing
1367 Mattullath's statement exactly as it occurs in the patent application:

> "The object of my invention is to construct a flying machine capable of commercial application for the transportation of goods and passengers.
>
> The fact that no successful flying machine of this character has ever been constructed proves nothing against the feasibility of such an undertaking. Enough has been accomplished up to the present day to demonstrate the possibility of dynamic flight upon the principle of the aeroplane propelled at
> 1368 an angle to the direction of flight."

The expression "flying machine of this character" in the passage quoted obviously refers to the sentence preceding the one in which it occurs; that is, it refers to the first sentence of the passage quoted and not to the third sentence.

XQ94. For purposes of stating whether you agree to this sworn statement of Mattullath, or disagree, you may consider that the machine referred to in the statement "that no successful flying machine of this character has ever been constructed" refers to an aeroplane flying machine.

Please now answer, one way or the other, whether 1369
you concur in Mattullath's statement or not?

A. As I understand your question you inquire whether I concur in the statement that up to the date of Mattullath's patent application no successful aeroplane flying machine had ever been constructed. My answer is "yes" and "no," depending upon the meaning attached to the word "successful." If by "successful" you mean that the aeroplane flying machine flew as it was designed to do, my answer is "no." If by "successful" you mean the aeroplanes developed at that date were capable of practical use for the commercial transportation of goods and passengers, I concur in 1370
Mattullath's statement. It is well known that before the date of Mattullath's patent application aeroplane flying machines flew and balanced themselves successfully in the air as they were designed to do, thus not only demonstrating the possibility of mechanical flight, but actually performing such flight.

XQ95. In order that your statement that before the date of Mattullath's patent application aeroplane flying machines flew and balanced themselves successfully in the air as they were designed to do, may be understood, I will ask you to give by name and place and date the concrete examples to which 1371 Langley
you allude in that statement?

A. A number of such flights have been recorded, of which some of the best known are those made by Langley's flying machines whose flights were made in the presence of reliable witnesses. The flight of his first aeroplane propelled by a heat engine occurred, as I remember, in May, 1896. This flight was witnessed and reported by Dr. Alexander Graham Bell. Subsequent flights were made under the direction of and witnessed by Mr. Charles M. Manly, as related by him in the Lang-

1413

1896 Zahm

1372 ley Memoir on Mechanical Flight. Langley's aeroplane of ~~[illegible]~~ 1896 made several flights ranging in length up to rather more than half a mile, during which the poise was excellent and the landing was made without mishap. In other words, this flying machine did all it was designed to do and may therefore be considered successful.

Langley

XQ96. But this alleged Langley machine did not carry a man, did it?

A. It did not carry a man because it was not designed to do so. It was the first of a series of Langley aeroplanes driven by heat engines, all of which flew successfully, and the last one of which
1373 formed a quarter scale model of a man-carrying passenger aeroplane which did fly successfully in the sense that it carried a man for a considerable distance through the air and landed on the ground without mishap or serious injury. I refer to Bleriot's flight on an aeroplane directly copied after Langley's, and whose performances are recorded in the Langley Memoir on Mechanical Flight, published by the Smithsonian Institution in 1911. The date of Bleriot's flight just mentioned was, however, subsequent to that of Mattullath's patent application.

Langley Memoir Pub. 1911.

XQ97. Please name the place and date of this
1374 alleged Bleriot flight alluded to in your last answer?

A. The flight was made in France, but I cannot give the date exactly. It was in 1907, as nearly as I recall.

XQ98. You do not state the matters of your two preceding answers from personal knowledge but only from what you have read. Is that correct?

A. From what I have read and from what I have directly heard reliable witnesses say of such flights.

By Mr. Toulmin: Then the answers are objected to as incompetent. 1375

XQ99. And this experimental Langley machine you have referred to, besides not having carried a pilot, had no means operable by a pilot, had there been one on the machine, by which to control the balance and direction of the machine. Is that correct?

A. The Langley aeroplanes whose flights I have mentioned had not all the controls commonly used by a pilot so far as I remember examining the machines in person, but they were followed by a Langley passenger aeroplane which had 1376 independently operable horizontal and vertical rudders and wings set at dihedral angles for insuring automatic lateral stability as in the models and propelled by a light and powerful gasoline engine capable of driving the machine through the air over a long voyage. It was an exact duplicate on a forefold scale of the Langley aeroplane which flew and balanced itself successfully without a pilot in the Summer of 1903, in Virginia, and since in addition it had the controls mentioned I may answer that it had means by which the pilot could govern its poise and steer its course in flight. The passenger aeroplane just 1377 described was completed in 1903.

Langley

Gasoline engine

Recess for Lunch at 1.05 P. M.

Resumed at 2.10 P. M.

Besides the independently operable horizontal and vertical rudders and the dihedral angle for maintaining automatic lateral stability, the machine was provided for fore and aft automatic stability by means of the well-known principle

1378 of the Penaud rudder, and furthermore its general poise in the air could be controlled by the shifting of the pilot's weight in the boat which he occupied.

Langley used gasoline engine,

But one of the chief claims to success in the development of the Langley models and of his passenger carrying aeroplane was the gasoline engine used on a small scale in one of the models and on a large scale in the passenger aeroplane. Up to the date of the construction of these engines Langley could find nowhere in the world a motor suitable for prolonged practical flight, and during his experiments he developed a gaso-
1379 lene engine of 52 horsepower weighing 200 pounds. With this reliable and powerful motor of such extremely light weight taken together with the provisions then known in the art for steering an aeroplane and controlling its balance, prolonged practical flight as we now understand it could easily be accomplished.

Langley

By Mr. Toulmin: All of the answer after the word "person" is objected to as a volunteered statement; also because apparently based on other than personal knowledge.

1380 XQ100. These small Langley experimental machines you have aptly termed models were superseded by the so-called Langley passenger aeroplane, were they?

A. They culminated in a Langley passenger aeroplane, since they led the way to its design and construction.

XQ101. And so they were experimental model machines intended to lead up to something further. Is that correct, that is, they were not further made or operated after the so-called passenger machine was built?

A. They were not in any sense abandoned, 1381
but the experiments both with the models and the passenger aeroplane were discontinued for lack of funds after the accident in launching the large machine on December 8th, 1903.

XQ102. Then this so-called passenger machine never in fact made a flight through the air, did it? In answering, please do so directly.

A. It was broken on the launching ways and did not have a chance to show its power of sustained flight in normal condition, but its capability of such flight was shown subsequently by the experiment of Bleriot previously cited

Langley

XQ103. And Professor Langley's experiments 1382
ceased with the failure of this so-called passenger machine to get off the launching ways into the air, did they not?

A. Yes, so far as his personal activities are understood, but experiments with his type of machine were continued by others, as I have already mentioned.

Failure L. get off ways last his experiments.

XQ104. Name who continued experiments with Langley's type of experimental machine in this country after Langley's failure to successfully launch what you call his passenger aeroplane?

A. The experiments I referred to were made 1383
in Europe, subsequent to 1903, but I do not recall similar experiments made in this country.

XQ105. How long subsequent to 1903?

A. As nearly as I can recall, Bleriot's experiments with the Langley type of aeroplane were made in 1907.

XQ106. Is the book L'Empire de l'Air referred to in your answer to XQ84, the one published by the Smithsonian Institution?

A. The copy I read was published in France, as I remember, and in the French language, and

1384 I procured it in the neighborhood of 1885. This
is the copy referred to in my previous answer.

XQ107. What success, if any, did the aeroplane illustrated in English patent to Henson of 1842 meet with?

A. It brought prominently before mankind
nearly all of the essential features of a practical aeroplane as now understood. It disclosed
wing-trussing very similar to that now used in
monoplanes and in the main surface of biplanes;
it disclosed independently operable horizontal
and vertical rudders for steering to right and
left and up and down; it disclosed a heat engine
1385 for motive power screw propellers for propulsion,
a wheeled chassis for launching and landing.
These main features taken together with balancing ailerons for lateral stability as disclosed
by Boulton in 1868 constitute the chief essential
features of an aeroplane for practical flight as
known at present.

By Mr. Toulmin: The whole answer is objected to as non-responsive and argumentative.

XQ108. Do you not know as a matter of history, that this Henson machine shown in this
1386 patent was never constructed and that Henson
never realized his intentions?

A. As I remember, a substantial model similar to the Henson aeroplane was constructed by Stringfellow, powered with a steam engine, which flew and balanced itself in the air. The details of the flight of this model as reported by Mr. Brearey, Secretary of the Aeronautic Society of Great Britain, and as quoted by Mr. Chanute

in his "Progress in Flying Machines" are given in 1387
the following paragraph:

> "The room which he had available for the experiments did not measure above 22 yards in length, and was rather contracted in height, so that he was obliged to keep his starting wires very low. He found, however, upon putting his engine in motion that in one-third the length of its run upon the extended wire, the machine was enabled to sustain itself; and upon reaching the point of self-detachment
> it gradually rose until it reached the 1388
> farther end of the room, where there was a canvas fixed to receive it. Frequently during these experiments it rose after leaving the wire as much as 1 in 7."

Answering your question more directly, I am not aware that Henson or his contemporaries tried to construct a passenger aeroplane embodying the features disclosed in his patent, and I believe that no motor was then available by which prolonged practical flights could be achieved.

XQ109. And Mr. Chanute, in the work you have
referred to, comments upon the model referred 1389
in the quotation you have made from Brearey by saying: "But the equilibrium was still insufficient for experiment out-of-doors, and the important problem of safely coming down was not solved at all, for to prevent breakage the apparatus had to be caught in a canvas fixed to receive it," does he not?

A. Yes, but in Henson's original patent wheels were provided for launching and also all the devices for steering and controlling a passenger aeroplane in flight used by certain successful

1290 modern aeroplanes, as, for example, those of Voisin Brothers and those of the Antoinette type before the adoption of ailerons. These latter machines made successful flights and even achieved world records with controlling mechanism practically equivalent in principle to that disclosed in the Henson patent of 1842; that is, independently operable horizontal and vertical rudders for steering in combination with a dorsal fin, or its equivalent, for maintaining lateral stability. Apparently, therefore, the problem of safely coming down was solved by Henson's invention, as well as the problem of equilibrium
1391 for experiment out-of-doors. I refer to those flights of the Antoinette and Voisin machines which were made without the use of ailerons prior to September, 1909, and subsequent to the beginning of the year 1908. These flights were made in France.

XQ110. But the fact remains that the machine of the Henson English patent was never built, and therefore never tried, does it not?

A. The last paragraph of my answer to XQ108 is my reply to this question, as nearly as I can give it accurately; that is, I am not aware that
1392 the machine of the Henson patent was ever built to carry a passenger.

XQ111. And as opposed to your statement that Henson solved the problem of equilibrium, does not Mr. Chanute, in the book from which you quoted, in speaking of the Henson patent say:

> "His general design evidences careful thought and possesses some excellent features, but the form of his aeroplane was crude and his equilibrium especially was deficient."

A. Yes, but that opinion was published in 1894

by a man who believed that an aeroplane should 1393
have automatic stability fore and aft as well as laterally before it would be adapted to successful flight with a passenger. This latter opinion was not very generally held by his contemporaries who had carefully studied the problem of aviation.

XQ112. In the concluding paragraph of your answer to XQ109, you say you do not believe a motor was then available by which prolonged practical flights could be achieved. The indoor experiments by Stringfellow to which you referred in the quotation that answer gives was conducted in 1846, as stated in the Brearey article from which
you took the quotation. The same article states 1394
that in 1844 another model was commenced by Henson and Stringfellow and completed in 1845, when it was tried out-of-doors but without success. In describing such experiments in 1845 Brearey quotes Stringfellow as saying: "Indeed the framework was altogether too weak. The steam engine was the best part. Our want of success was not for want of power or sustaining surface, but for want of proper adaptation of the means to the end of the various parts." I therefore ask you if the same authority which relates the labors of Henson and Stringfellow does not also state that they had
at their disposal, as the best part of what they 1395
possessed the steam engine?

A. They may have had a steam engine developing a small fraction of one horsepower and capable of propelling an aeroplane model successfully for a very short distance, but as Maxim has pointed out in his patent previously quoted, prolonged practical flight with a passenger-carrying aeroplane was not achievable at the time of Henson's and Stringfellow's experiments.

Adjourned at 4:35 P. M. to to-morrow, Nov. 17th, at 10:30 A. M.

1396 New York, N. Y., Nov. 17, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

(Answer continued.)

The quotation referred to in Maxim's British patent #16,883 of 1889 reads: "The aerial machines hitherto constructed have been very heavy in proportion to their power, having a weight of from five hundred to one thousand pounds for each horsepower of the motor. Consequently they have failed to rise in the air." It is true that extremely
1397 small engines like those of Stringfellow had been constructed weighing much less per horsepower than the ones just mentioned by Maxim, but they developed only a small fraction of one horsepower and discharged all their exhaust steam into the air, thus requiring many pounds of water per horsepower per hour in addition to the weight of the fuel the boiler and the engine itself. Even up to the present date so far as I am aware, no one has succeeded in maintaining prolonged practical flights in an aeroplane propelled by a steam engine. Langley after successfully using the steam engine for the short flights hitherto mentioned was com-
1398 pelled to abandon that type of motor when he undertook to produce a passenger aeroplane capable of prolonged practical flight.

XQ113. Does the publication by the Smithsonian Institution of Washington of Mouillard's writings disclose the alleged proposal of wing-warping?

A. I do not know, never having seen a copy of said publication.

Redirect examination by Mr. Newell:

RDQ114. In answer to XQ109 you mentioned a dorsal fin whose function was to accomplish lateral stability. Will you please explain a little

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more in detail what such a dorsal fin is and how 1399
it tends to right the machine if tilted?

By Mr. Toulmin: Objected to as apparently assuming that the machine of the Henson patent in which latter this dorsal fin is illustrated was constructed, whereas the witness has testified that he was not aware of such machine was ever constructed.

A. The dorsal fin disclosed in the Henson patent is a vertical keel placed above the center of the machine and extending fore and aft from the
front edge nearly to the rear edge of the main 1400
plane. When the machine is tilted laterally and tends to slide sideways due to the lateral slope, the air striking this keel exerts a righting torque tending to restore the balance and at the same time check such lateral sliding. The effect is very similar to that of the vertical surfaces in a box kite, or the surfaces placed at a dihedral angle, as in the Langley and the Antoinette monoplanes. Such aeroplanes are said to possess automatic or inherent lateral stability because when tilted they automatically return to their
normal level poise. I may add also that the 1401
dorsal fin has been added to one or more modern aeroplanes.

Langley

RDQ115. Am I right in understanding that such a vertical fin tends to right the machine when sliding sideways because of the pressure thereon exerted by the air due to such sliding, which consequent pressure is above the center of gravity of the machine?

A. Yes, the pressure on the keel which is well above the center of gravity, forms with the weight of the machine a righting torque or couple which restores the machine to its natural level; the

1402 pressure tends further to check such lateral sliding.

RDQ116. In your cross examination you spoke of the Antoinette monoplane. Will you please state whether or not that machine is extensively used at the present day, and where the horizontal and vertical rudders are placed with reference to the wings?

A. It has been very extensively used in Europe for several years and was extensively flown in this country last year. The horizontal and vertical rudders which are independently operated by the pilot, are placed to the rear of the wings
1403 and some distance from them.

RDQ117. Is this also the fact with the Bleriot monoplane?

A. Yes.

RDQ118. Where are the vertical and horizontal rudders in the present day machines of the complainant company located, in front of the main planes or to the rear?

A. Well to the rear.

RDQ119. In the Wright machine flown at Fort Meyer in 1908 or 1909, was the vertical rudder single or was it two vertical rudders placed side by side and operated simultaneously?

1404 A. It comprised two vertical surfaces placed side by side and operated simultaneously.

RDQ120. And were they in front or in the rear?

A. In the rear of the wings.

Recross examination by Mr. Toulmin.

RXQ121. In answering redirect question 115 you say the pressure on a vertical fin or keel when above the center of gravity will tend to

right the machine to its natural level when the 1405
machine slides sideways and such fin receives its side pressure. If such fin or vertical surface is placed forward of the vertical axis of the machine or rearward of such axis, and the machine slides sideways, as when tilted out of lateral balance, such fin or vertical surface will cause a turning of the machine on its vertical axis, will it not?

A. It may or it may not, depending upon the placement, dimensions of the keel, the angle of impact of the air against it, the resultant force of the air against the remaining parts of the
machine, etc. In general I should say that such 1406
a vertical keel can be so shaped, dimensioned and placed as to make such vertical spin extremely small, if not negligible.

RXQ122. Well, if such fin or vertical surface were placed as stated in my last question and was large enough to give the effect stated in your answer to RDQ115, when placed as that answer contemplates, then would not such fin or plane being located either forward of the vertical axis or rearward of it, cause such turning of the machine on a vertical axis should the machine slide sideways when laterally out of balance?

A. An incompetent designer can so proportion 1407
and place such vertical keel as to cause the aeroplane to spin around and move tail foremost; a competent designer who takes into account all the resisting surfaces and mass of the aeroplane can so design a vertical keel as to steady and stabilize the machine in its flight.

By Mr. Toulmin: Objected to as pure evasion.

ALBERT F. ZAHM.

Adjourned subject to further notice.

1408 New York, N. Y., November 27, 1911.

Met pursuant to notice by correspondence.

Present—Counsel as before.

FRANK N. WATERMAN, a witness introduced on behalf of defendants, having been duly sworn, deposes and says in answer to questions by Mr. Newell:

Q1. Please state your name, age, residence and occupation?

A. Frank N. Waterman; age 46; residence, Summit, New Jersey; occupation, Consulting Engi-
1409 neer.

Q2. Please state what experience you have had tending to qualify you to testify as an expert in litigation concerning patents?

A. I received a technical education at Cornell University, graduating in 1889 with the degree of Mechanical Engineer. Immediately after leaving college I engaged in the practice of my profession, and for a number of years was engaged in the testing, erection and operation of electrical and steam machinery in the employ of the Westinghouse Electric Co. Subsequently I was engineer of the New York office of the Westinghouse Electric & Mfg. Co., engaged in consulting and advisory
1410 work. During this time I was frequently called upon to examine patents and patented structures, and to pass upon the value and operativeness of structures set forth in patents. I finally became Engineer of the Legal Department of the Westinghouse Co. Since the year 1900 I have not been connected with any Company, but have been engaged in the practice of my profession of Consulting Engineer. During this time I have frequently been called upon to testify as an expert in litigations involving patents, and have so testified altogether in a large number of cases.

Q3. Have you read and do you understand the 1411
patent in suit to Orville and Wilbur Wright, #821,393?

A. I have read the patent and believe that I understand the same.

Q4. Consider the patent in suit in relation to the literature of the art which is in evidence in this case or known to you, collecting and comparing those parts which relate to the construction and required mode of operation of the machine disclosed in the patent. In this connection you may consider also the deposition of Wilbur Wright heretofore given and you may refer to the prior art
recognized in the patent in suit. 1412

Recess for Lunch

A. The patent is entitled "Flying Machine" and it recognizes a developed class of such machines, as well as a "usual custom" in their construction. It discloses a structure comprising a parallel pair of normally flat planes suitably trussed together, one over the other, for strength, a longitudinal equilibrium device or horizontal rudder in front of the planes, and lateral equilibrium means comprising a rear vertical rudder connected to and
operated in definite co-relation with a warping or 1413
twisting movement given to the planes themselves.

It goes without saying that the machine disclosed is of itself without utility. Indeed I will shortly call attention to the fact that the patentees themselves have said it is not a practical flying machine and does not even solve the problem of equilibrium. The most that can be said is that it is a device with which a person willing to learn by long continued repeated attempts, at the risk of his life might, under favorable and restricted conditions, learn to glide from a higher to a lower

1414 level, or, as the prior art taught, rise for an instant on an ascending current of air to a level higher than the original starting point. In other words, as the prior art taught, the Wright machine of the patent is in no sense essential to such gliding or momentary soaring, but what is essential is an extreme degree of personal skill, not to say also extreme good fortune in having lived to attain it.

In considering the title of the patent in suit therefore, it is essential to observe that the patent is notable in what it omits. Thus the patent contains no disclosure of any motive power devices. It discloses no motor, or power-transmitting means,
1415 or propeller; it discloses no location for either motor or propeller; it discloses no means of control of any power devices, nor any necessary change of position of the operator in the presence of such devices, and is equally silent as to how the power of a motor exerted to turn a propeller is to be prevented from overturning the machine.

In view of these facts it is evident that the machine of the patent in suit is not a flying machine in the sense of a dynamically-driven man-carrying apparatus, but is a gliding machine, and the "class of flying machines" which the patent cites and the "usual custom" in such machines which it recog-
1416 nizes, will be found set forth in the literature dealing with gliding flights under the influence solely of the force of gravitation and the natural wind currents of the air.

It is to be borne in mind, therefore, in considering the Wright patent that it does not instruct anyone how to build or control a power-driven or dynamic flying machine; that it was not until long after the filing of the patent in suit that the patentees themselves ever constructed or flew a power-driven flying machine; that the art did not teach where to locate or how to install and control motive

devices, but on the contrary gave erroneous and 1417
fatally defective instruction on this point; and that until the development of automobile motors, it did not have any sufficiently light practical motors.

The literature of the art to which the question refers shows that not only does the patent in suit not disclose a dynamic flying machine, but it does not disclose a machine which can become a practical dynamic flyer when the knowledge as to where and how to install a motor and propeller was achieved and the motor and propeller were themselves developed, and still further it appears that the patentees did not even disclose
a practical gliding machine, even overlooking 1418
the impractical character of the equilibrium devices but on the contrary withheld and left out of the patent information as to the correct formation of the aeroplane which their own published writings show that they were acquainted with prior to the application for the patent in suit and which they knew to be of the most essential character in the production of a practical gliding apparatus.

These matters I will consider more in detail after having first considered what features the patent and the literature of the art alike show
to be essential. 1419

The details of construction such as the structure of the normally flat aeroplane, the loose jointing of the upright separating posts, the trussing, the curving of the horizontal rudder, the mounting of the vertical rudder, and the location and operation of the ropes whereby the planes are twisted and the vertical rudder turned, have been so frequently and fully set forth in the record that repetition seems

1420 unnecessary. The features which I understand are essential and important to this controversy are primarily the means which the patent sets forth for establishing and preserving lateral equilibrium.

Adjourned to tomorrow, Nov. 28th, at 11 A. M.

New York, N. Y., Nov. 28 1911.

Met pursuant to adjournment at 11 A. M.

Present—Counsel as before.

Witness continues:

1421

It appears from the exhibits in the record that the patentees began their study of aeronautics about the year 1896 and no doubt they were at that time impressed, as I have been in my study of this case, with the very large amount of literature upon the subject and the very great success which had been attained both in human flight by aeroplane gliding machines and in automatic flight by small gliding machines and small power-driven machines propelled by rubber cord, compressed air or diminutive steam motors. It is astonishing to one who, like myself,
1422 has not been in close touch with this art (in which class the patentees were included in 1896 or thereabouts) to find that flights counted in the thousands have been successfully made by many different men, some of them exceeding in length a thousand feet, and that small machines without any human guidance whatever and without power of any kind other than that derived from the wind and from gravitation had flown as far as 1800 feet in perfectly balanced and stable flight, while small power-driven machines

had flown as far as 3,000 feet, or considerably 1423
more than half a mile.

This literature is full of matter of intense interest, containing as it does the record of an immense amount of careful observation, clear thinking and reasoning and successful accomplishment. Contrary to my preconceived notions it is not a record of failure but of remarkable and inspiring success.

To understand either the patent in suit or the exhibits in evidence pertaining to the work of the Wright brothers, the patentee, it is necessary to know something of the previous
accomplishments which these gentlemen studied, 1424
as they say, at the beginning of their interest in the subject. In Defendants' Exhibit "Wright Brothers Article in Century Magazine for September 1908" and on page 642 of that magazine, they say, referring to the summer of 1896 and the years following:

> "We then studied with great interest Chanute's 'Progress in Flying Machines,' Langley's 'Experiments in Aerodynamics,' the 'Aeronautical Annuals' of 1895, 1896 and 1897, and several pamphlets published
> by the Smithsonian Institution, especially 1425
> articles by Lilienthal and extracts from Mouillard's 'Empire of the Air.' The larger works gave us a good understanding of the nature of the flying problem, and the difficulties in past attempts to solve it, while Mouillard and Lilienthal, the great missionaries of the flying cause, infected us with their unquenchable enthusiasm, and transformed idle curiosity into the active zeal of workers."

Recess for Lunch.

1426 Without going extensively into this literature it is sufficient to note that Lilienthal, one of "the great missionaries of the flying cause," mentioned above, made in the neighborhood of 2,000 flights, with the aid solely of gravity and the wind by way of propelling means, and finally lost his life through defective construction of his machine just as many men have since lost their lives from the same cause in Wright machines. So also this literature shows that numerous others, including Pilcher and Chanute or men associated with them, made large numbers of successful gliding flights. Pilcher alone of all these losing his life, again
1427 through defective mechanical construction. Regarding this Mr. Wilbur Wright says in the article Defendants Exhibit "Wright 1901 Address," speaking more particularly of Lilienthal:

> "However, he did not escape being overturned by wind gusts several times, and finally lost his life through a breakage of his machine, due to defective construction. The Pilcher machine was similar to that of Lilienthal, and like it, seems to have been structurally weak; for on one occasion, while exhibiting the flight of his machine to several members of the Aeronautical So-
> 1428 ciety of Great Britain, it suddenly collapsed and fell to the ground, causing injury to the operator, which proved sadly fatal."

This literature contains also the reports of many investigations of the shape of wings, that is, aeroplanes, and many records of successful flights of small machines both as gliders and power-propelled, by rubber bands or small compressed air or steam motors. Among these the power-propelled machines of Penaud and Langley, the latter of which flew 3,000 feet propelled by steam power and without human control, and the gliding machine of

Huffaker, which glided stably without power or 1429
human control, 1,800 feet, may be mentioned.

An article by the latter gentleman, Mr. E. C. Huffaker, entitled "The way of an Eagle in the Air," contained on pp. 128 to 141 of the Aeronautical Annual for 1897, being one of the books which the Messrs. Wright say they studied, in the above quotation, contains much that is of interest with regard to gliding flights, and judging by results may well have been the guide which they followed in entering the aeronautical field. This article describes the flight of birds, considers the theoretical principles involved and describes the
application of the observations to successful gliding 1430
machines. The article tells how to construct such a machine, how to make the various adjustments to overcome initial defects in its gliding flight, and says that the greatest difficulty encountered was found when the machine came to earth in a rapid curve with one wing greatly raised. He says:

> "My experiments, however, have led me on to a construction which seems to be free from this fatal tendency. * * * The most effectual means I have found for preventing this in artificial wings consist in increasing the angle at the tips and compen-
> sating this by decreasing the angle near the 1431
> body, for a steady movement can only be obtained when the general angle of elevation is small. * * * The angle at the tips must be sufficiently great to ensure the requisite lift, and the reverse inclination near the body sufficient to acommodate the air from primary portions. It is chiefly upon this adjustment that the lateral stability depends."

1432 Thus we have in the 1897 Aeronautical Annual a disclousre of warped or twisted wing surfaces as imparting stability to gliding machines.

According to Defendant's Exhibit "Wright 1901 Address," Messrs. Wilbur and Orville Wright, after studying these publications began the construction of a gliding machine provided with means for warping the wings, which machine they tested in gliding flights at Kitty Hawk, North Carolina, in the Summer of 1900. In other respects than this warping of the wings, perhaps suggested by Mr. Huffaker's writings, the machine shown in the exhibit "Wright 1901 Address" is substantially the
1433 Chanute double-deck gliding machine described by Mr. Chanute in the 1897 Aeronautical Annual, beginning at page 30 and shown in Fig. 2, Plate VI, and Fig. 2, Plate VIII and fully described and illustrated in Defendant's Exhibit "Gliding Experiments." Instead, however, of having a rear horizontal rudder, this first machine of the Wrights had the horizontal rudder placed in front and dispensed with any tail structure at all. It appears that this machine had aeroplanes or wings curved in transverse section, according to the parabolic curvature of Lilienthal and others, and that it was, except as to the front horizontal rudder and absence
1434 of any tail, a machine following substantially the instructions of the prior art which the first quoted article says was studied. It appears that short gliding flights were made with this machine, and that in 1901 further tests were made with a second machine exactly like the first in theory and method of operation but having a greater curvature to the wings. This was found to be inoperative, or as the "Wright 1901 Address" says (p. 501):

> "It was apparent that something was radically wrong, though we were for some time unable to locate the trouble."

The difficulty proved to be a *slightly incorrect curvature* to the wings, which was corrected and successful glides made for short distances. 1435

Following briefly the further development, Defendant's Exhibit "Wright 1903 Address" shows that in 1902 a third machine was tried like those of the preceding years, except that the tail of the Chanute machine which had been discarded, was restored to the extent of the provision of about twelve square feet of vertical tail surface, in the form of what may be called for lack of a better term, a double vertical rear rudder. This was subsequently made single. It appears that after numerous attempts, some of which narrowly 1436
escaped a tragic outcome and one of which wrecked the machine, it was found to be too dangerous, and after various changes in wing shape without success (p. 7):

> "It was finally concluded that the best way of overcoming the difficulty was by making the tail movable like a rudder."

Regarding this, the "Wright 1903" Address says, referring to the experiments of 1902:

> "With this improvement our serious troubles ended and thereafter we devoted 1437
> ourselves to the work of gaining skill by continued practice. * * *
>
> "With the method we have been using the capacity of control is evidently very great. The machine seems to have reached a higher state of development than the operators. As yet we consider ourselves little more than novices in management. A thousand glides is equivalent to about four hours of steady practice. Far too little

1438 to give any one a complete mastery of the art of flying. * * *

"Before trying to rise to any dangerous height, a man ought to know that in an emergency his mind and muscles will work by instinct rather than by conscious effort. There is no time to think."

With this change, flights of considerable length, although still much shorter than those credited to Lilienthal, were made, the longest being stated as 622 1-2 feet, the time being 26 seconds.

In March of the following year, 1903, appli-
1439 cation for a patent was made, which resulted in the patent in suit, and I call attention particularly to the fact that no application was made, so far as appears, for the machine of preceding years, and it was only when the necessity of combining with the warping of the wing surfaces, a vertical compensating rear rudder was discovered that application for patent was finally made.

Thus it will be seen, from the history of the work thus set forth in these exhibits and from the review of the prior knowledge with which the patentees started, that starting with the Huffaker
1440 conception of warped wing surfaces as a means of securing lateral equilibrium, the Messrs. Wright found that in a man-controlled machine it was essential for safety to combine therewith a vertical rear compensating surface. The philosophy of the mode of operation of these conjoined means is found in the patent in suit, and they constitute, according to my understanding, the essential feature of the Wright machine of the patent. And it should be noticed in this connection that this so-called vertical rear rud-

der was not added as a means of steering and has 1441
no function except as a means of preserving lateral equilibrium in connection with a machine having wings warped to different angles at different points.

In view of the fact that the patent and these Wright addresses of 1901 and 1903 respectively lay much stress on the use of a front horizontal rudder, it may perhaps be questioned whether it is correct to say that this combination of a vertical compensating surface with warped wing surfaces is *the* essential feature of the patent, but upon this subject it is sufficient at
present to note that this front rudder not only 1442
has nothing to do with lateral balance, but is no longer used by the Wrights themselves, having been, as the record shows, abandoned in favor of the rear horizontal rudder position of the prior art Chanute machine.

Turning now to the Wright patent, and passing over the structural details pertaining to the formation of the wings and the assembling of the various parts, I find beginning at line 54, page 2, a description of the control rope connections by virtue of which the wings are warped and the rear vertical compensating surface simultaneously turned
toward the side of least wing inclination. The 1443
mode of accomplishing this result is exceedingly ingenious and is based upon the fact that if we have a loose-jointed rectangular structure shortening one diagonal, by inclining the vertical sides will lengthen the other. Thus examining Fig. 1, it will be seen that the vertical end posts 8 constitute, with the flat planes 1, 2, a rectangle, and that the control rope 15 passing diagonally upward from the lower corner *e* to the upper corner *d* constitutes one diagonal of the rectangle, while the rope 19 extending from the lower corner *h* diagonally

1444 upward to the corner *a* constitutes the other diagonal of the rectangle. These ropes are connected to corresponding corners on opposite wing tips of the machine, and the rope 15 is connected at the center of the machine to a cradle 18, by the endwise motion of which, in the direction of the arrow, the diagonal *c, d* is shortened, while the corresponding diagonal at the opposite or right-hand end is lengthened. At the same time the diagonal 19 at the left-hand end is lengthened and its corresponding diagonal at the opposite end is shortened. This results in a progressive warping of the surface indicated by the dotted lines in Fig. 1 and more
1445 clearly shown perhaps in Defendant's Exhibit "Sketch #1," stated by Mr. See to correctly show the effect of operating these warping ropes. Fig. 4 of this exhibit shows the front view of the warped plane, while Fig. 2 shows the front view of the same plane when not warped.

Adjourned at 4:30 P. M. to tomorrow, Nov. 29th, at 11 A. M.

New York, N. Y., Nov. 29, 1911.

Met pursuant to adjournment, at 11 A. M.

1446 Present—Counsel as before.

Witness continues his answer:

Figs. 2 and 3 of the patent show the compensating surface 22 in plan and side view respectively. It is hinged on vertical pivots 25 and has an operating pulley 26, around which cords 27 are led diagonally to each side and suitably attached to the warping rope 19, as clearly indicated in Figs. 1 and 2. This attachment of the ropes 27 is so made according to the specification, that when the planes are in their normal flat condition, this compensating surface or so-called rudder 22 stands

in a direct fore and aft position, but when the 1447
planes are warped as shown in Fig. 1, it is, by the act of warping, turned toward the side on which the wings have the least angle of incidence, that is to say the side on which the planes are bent to most nearly enter the air edgewise.

I am assuming in this description that it has already been made clear to the Court that when a flat plane is presented exactly edgewise to the air and moved forward, there will be a resistance to motion but no supporting effect, and that if the front edge is slightly raised so that the plane is presented nearly but not quite edgewise, then the resistance to forward motion will be increased 1448
but a lifting effect will also be produced, the amount of which depends upon the departure from the exact edgewise position. I also presume that the terminology of the art is understood so that the "angle of incidence" will be recognized as the angle by which the planes depart from the edgewise relation, the term "lift" understood to designate the upward or supporting pressure of the air, and the words "drift" or "resistance" to designate the opposition which the air opposes to forward motion.

The term "aeroplane," as used in the art I assume is understood to designate any wing-like 1449
surface whether curved or flat in the direction of flight, which by motion through the air yields a supporting force, and that the term "normally flat aeroplane" used in the patent is understood to designate a supporting surface which, in the direction of flight, is not curved but a true plane except insofar as its surface may be bagged somewhat by the air pressure; the word "normally" signifying that the plane is flat in the undisturbed relation, but may be warped or twisted, at the will of the operator, conformably to the description of the patent.

1450 By virtue of the construction above described, wherein the vertical compensating surface or rudder is permanently attached to and controlled by the warping of the wings without any separate or independent control, it will be seen that this so-called rudder is in no sense a steering device, but a compensating surface constituting an essential part of the means for securing lateral balance or equilibrium.

The essential character of this simultaneous warping and operation of the rear compensating rudder is stated in the specification, page 4, lines 53 to 63, as follows:

1451 "We wish it to be understood, however, that we do not limit ourselves to the particular description of rudder set forth, the *essential* being that the rudder shall be vertical and shall be so moved as to present its resisting-surface on that side of the machine which offers the least resistance to the atmosphere, so as to counteract the tendency of the machine to turn around a vertical axis when the two sides thereof offer different resistances to the air." (Italics mine.)

1452 I note in this connection that during the prosecution of their application in the Patent Office, the Examiner understood the so-called rudder to be a steering device and stated that how it was connected was merely a matter of taste, involving no invention. The applicants, in reply, however, pointed out that their so-called vertical rudder was "in no sense a steering device" but acted merely to compensate for the increased resistance offered by one end of the machine as compared to the other when the wings were warped. Quoting from Paper No. 5, amendment A, filed July 13, 1904, the applicant said: 1453

> "As to the vertical rudder, *it is in no sense a steering device*, but is simply for correcting the increased resistance offered by one end of the machine over the other arising from the different angles at which the ends of the planes are presented to the wind," * * *
> (Italics mine.)

Continuing, the applicants point out that this compensating effect occurs automatically and imperatively by virtue of the permanent con- 1454
nection of the rudder to the warping ropes, and in a later amendment they more fully explain the reasons why this operation of the compensating rudder is absolutely essential, the description being found on page 4 of the patent, beginning at line 10 as follows:

> "It will be observed in this connection *that the construction is such that the rudder will always be so turned* as to present its resisting surface on that side of the machine on which the lateral margins of the aeroplanes present the least 1455
> angle of resistance. The reason of this construction is that when the lateral margins of the aeroplanes are so turned in the manner hereinbefore described as to present different angles of incidence to the atmosphere that side presenting the largest angle of incidence, although being lifted or moved upward in the manner already described, at the same time meets with an increased resistance to its forward motion, and is therefore retarded

1456 in its forward motion, while at the same time the other side of the machine, presenting a smaller angle of incidence, meets with less resistance to its forward motion and tends to move forward more rapidly than the retarded side. This gives the machine a tendency to turn around its vertical axis, and this tendency if not properly met will not only change the direction of the front of the machine, but will ultimately permit one side thereof to drop into a position vertically below the other side with the aeroplanes in
1457 vertical position, *thus causing the machine to fall. The movement of the rudder hereinbefore described prevents this action*, since it exerts a retarding influence on that side of the machine which tends to move forward too rapidly and keeps the machine with its front properly presented to the direction of flight and with its body properly balanced around its central longitudinal axis." (Italics mine.)

Stated in other words, this means that unsymmetrical warping of the wings not only will
1458 not correct a fault of lateral balance, but will actually accentuate it, because the lifting effect depends upon the maintenance of speed and, if one side of the machine presents a greater resistance to the air than the other, the machine will spin around the side of higher resistance and reduced speed causing the other wing to climb and the machine to fall. The rear compensating surface by presenting a counterbalancing forward resistance prevents the machine from spinning by causing both sides to be equally

The essential character of this construction

retarded, and so causes the wing of greatest 1459
twist or inclination to the air to rise and restore the lateral balance.

by virtue of which "the rudder will always be so turned as to present its resisting surface on that side of the machine on which the lateral margins of the aeroplanes present the least angle of resistance," is repeatedly affirmed in this record. Thus in the article signed by Messrs. Orville and Wilbur Wright, Defendant's Exhibit "Wright Brothers Article in Century Magazine for September 1908," page 645, the patentees say, writing in September 1908:

1460

> "We also discovered that in free flight, when the wing on one side of the machine was presented to the wind at a greater angle than the one on the other side, the wing with the greater angle descended, and the machine turned in a direction just the reverse of what we were led to expect when flying the machine as a kite. The larger angle gave more resistance to forward motion, and reduced the speed of the wing on that side. The decrease in speed more than counterbalanced the
> effect of the larger angle. The addition 1461
> of a fixed vertical vane in the rear increased the trouble, and made the machine absolutely dangerous. It was some time before a remedy was discovered. This consisted of movable rudders working in conjunction with the twisting of the wings. The details of this arrangement are given in our patent specifications, published several years ago."

1462 Thus the essential character of the vertical rudder working in conjunction with the twisting of the wings is again affirmed.

As bearing upon this point I may note that the prior art already knew that increasing the angle of the wing tip would retard it and not elevate it, for Mr. Huffaker pointed this out in his article in the Aeronautical Annual for 1897 on page 139, exhibiting a tendency to turn or skid he said:

> "All that is now necessary is to increase the resistance of the advancing wing. This may be done by increasing the angle of elevation at the tip. This should increase the
> 1463 lifting power of the wing as well, and so elevate it; but it appears that the resistance increases more rapidly than the lift. At any rate *a wing is held back by increasing its outer angles.*" [Italics mine.]

Thus the Wright Brothers were not the first to discover the increased resistance of an unsymmetrically warped wing. What they did was to combine with the wing-twisting means a vertical rudder forcibly constrained to correct the change of resistance. I may note in this connection that the Messrs. Wright apparently were aware of this
1464 disclosure of Mr. Huffaker's, for referring to a certified copy of an answer filed by the Wright Company in the United States Circuit Court for the Southern District of Ohio, Western Division, wherein as I understand they were answering a bill of complaint charging infringement of a patent to Charles H. Lamson by virtue of the wing warping, they make the following citation:

> "The Aeronautical Annual, 1897, published by W. B. Clarke & Co., Boston, Mass., pages 128 to 141, 'The Way of the Eagle in the Air,' by E. C. Huffaker."

This is the article from which I have just quoted, 1465
and the quotation is taken from the pages cited.

Recess for Lunch.

Defendant's counsel introduces a certified copy of the answer referred to, and requests that the same be marked as Defendant's Exhibit "Complainant's Answer in Lamson suit."

He also introduces a copy of the Lamson patent 366,427, referred to in said answer, and requests that it be marked as Defendant's Exhibit "Lamson Patent." 1466

Again in an affidavit signed by Messrs. Wilbur & Orville Wright and filed in the United States Circuit Court for the Western District of New York, Nov. 29, 1909, a certified abstract of which is before me, I find the following:

"The complainant's experimental machine of 1900 and 1901 possessed wing tips adjustable in opposite directions to different angles of incidence. But it had no vertical or horizontal rear rudder, complainants believing that the adjustment of the wing tips
alone would provide lateral control. But 1467
experiment proved that this was a mistake. The wing with the greater angle would not maintain its elevation, because, as we finally discovered, the greater horizontal resistance caused that wing to lag more and more behind the other wing; and since the lifting power is dependent upon speed as well as angle, the effect of the reduced speed balanced the lifting effect of the lifting angle, and the wing with the greater angle failed to rise. We thus failed to attain the result

> 1468 we wished. After much study of the phenomenon, we discovered the theoretical cause and remedied the trouble by inventing the machine of the patent in which the difference in horizontal resistance is corrected by an adjustable vertical rudder, while the difference in lifting effect is utilized in controlling the lateral balance of the machine."

Here, therefore, is a sworn statement that coordinated operation of the vertical compensating rudder to the wing warping is *essential* in controlling the lateral balance of the machine.

As showing in the same affidavit that the rudder
1469 is in no sense a steering device, the Messrs. Wright say:

> "We have repeatedly made complete circles with the rear rudder permanently connected with the wires which warp the planes as described in the particular form shown in the patent. Circles were usually made in *a direction opposite to that which would have been taken if the rudder had possessed the functions of an ordinary ship's rudder.* * * *
>
> It is true that the machine was not turned
> 1470 to right or left by using the rear rudder as a boat's rudder is used, but by warping the wings the whole machine could be given a lateral inclination and caused to slide off to right or left according as the right or left wing was lower than the other. In circling it was necessary to set the inner wing to a larger angle of incidence than the outside wing, because it moved in a smaller circle than the outside wing and of course had less speed. The inside wing therefore had a greater resistance than the outside

> wing and tended to fall behind and the machine swung round the circle with the rear rudder set over toward the outside wing and receiving a pressure on the side toward the outside wing, a condition exactly opposite from what would have existed if the rudder had been a mere steering device." [Italics mine.] 1471

It is clear, therefore, that not only must the compensating or counterbalancing surface be operated in conjunction with the warping of the wings, but this surface is "in no sense a steering device" operating in fact in a manner "exactly opposite" to such a device. 1472

> Defendant's counsel introduces in evidence the certified abstract referred to, and requests that the same be marked Defendant's Exhibit "Extract from Wright Affidavit in this Case."

In his testimony given in this case Mr. Wilbur Wright states, as I understand him, that in 1902 a machine was built having fixed rear vanes, but that it caused numerous accidents and was unsafe. He says:

> "Q134. Did you consider that this machine was a practically successful gliding machine? 1473
>
> A. The expression "practically successful" is one to which a wide range of meanings might be assigned by different persons, but *in view of the numerous accidents* in the nature of bad landings *from which we were very glad to escape with our lives* sometimes, we were not satisfied with it, and felt that

1474 immediate improvement was needed." (Italics mine.)

He further testifies that these rear vanes, fixed in position, were removed and a single vertically pivoted surface put in its place. As to its manner of use he testifies:

> "Q140. Please describe where it was located and just how it was connected up, and how it was moved while in flight?
>
> A. It was located and connected up and moved in the manner described in the patent in suit, I believe.
>
> 1475 Q141. That is, its operating cables or wires were connected up to the wing-warping cables or wires so that the rudder was moved whenever the wings were warped.
>
> A. I think that is correct."

Mr. Wright testified that the purpose of this movable rear rudder was to counterbalance the forward resistance of the wing having the greatest angle of incidence and is not in any sense a steering device like a ship's rudder. In answer to XQ170, for instance, he makes the following statement:

> 1476 "Neither my brother nor myself, so far as I now recall, have proposed to steer or have steered a heavier-than-air flying machine in the manner that a ship's rudder steers a ship."

I note also that Dr. Zahm, testifying as a witness on behalf of defendants in this case, also agrees that, in the machine of the patent in suit, the co-ordinate working of the rear rudder

with the warping of the wings is essential. For 1477
instance in his reply to Q62 he says:

> "In the machine of the patent in suit it is necessary to work the vertical rudder to counteract the large vertical torque of the wings when warped."

Mr. See's testimony given on behalf of the complainant is to the same effect. Thus in his answer to Q5 he says:

> "The operation may be briefly described as follows, referring to Fig. 1.
>
> Assume the machine to be flying forward, 1478
> with everything lovely. Now, from some cause, of which I understand there may be a hundred a minute in flying, the side of the machine at the left in the picture starts to drop. If this keeps on, it means death and destruction. The operator shifts the cradle and causes the lateral margins at the dropping side to take on an increased angle of incidence while those at the opposite side of the plane take on a lessened angle of incidence. The increased angle of incidence at the dropping side
> would ordinarily bring about an increased 1479
> lifting effect at the dropping side and put the machine on an even keel again. But this increase in the angle of incidence at the dropping side has increased the resistance to the forward advance of that side, while the lessened angle of incidence at the opposite side has lessened the resistance to that side, the result being that the dropped side is retarded in its advance while the opposite side advances at

1480 greater speed and, owing to this greater speed, gives to that side a superior lifting effect, notwithstanding that side has the least angle of incidence. The machine starts to turn on a vertical axis, and, *if this matter keeps up, the attempt to correct careening will have made the matter worse, and the machine will tip up and fall. But at the same time* the non-dropping side is adjusted to lessen the angle of incidence, and thereby decreased in resistance to advance, *the rear vertical rudder moves* toward the non-dropping side
1481 so as to present to the wind its side nearest the non-dropping side of the machine, the retarding influence of the wind pressure on *the rudder thus compensating for the inferior resistance to the advance offered by the non-dropping side. Under these conditions the turning on a vertical axis is prevented and the corrective influence of the adjustment of lateral margins of the planes becomes effective.*" (Italics mine.)

Adjourned at 4.45 P. M. to Dec. 1st, at 11 A. M.

1482

New York, N. Y., Dec. 1, 1911.

Met pursuant to adjournment, at 11 A. M.

Present—Counsel as before.

(Witness continues.)

Similarly Mr. W. J. Hammer, a witness on behalf of complainant, who qualifies as an expert of long experience, testifies referring to a Wright machine or machines seen by him in 1903, as follows:

"XQ65. If I understand you correctly, because the tiller ropes of the rear vertical

rudder were connected to the warping ropes, 1483
the planes could not be warped without turning the rear rudder, and the rear rudder could not be turned without warping the planes. Is that correct?

A. This is my understanding.

XQ66. And the rear rudder was turned (when the planes were warped) sufficiently to counteract the tendency of the machine to spin around a vertical axis, due to the unequal resistance on the two sides of the machine when the planes were so warped. Is that correct?

A. As I understand the operation, from 1484
a scientific knowledge of the machine, I believe that the rudder was turned toward the side of the least angle in order that its effect, together with that of the action of the side of the plane with the least angle, would counterbalance the effect produced on the side of greatest angle.

XQ67. Your answer to my question is substantially in the affirmative, is it not?

A. There is not only an action of the machine turning on a vertical axis, when the lower side is given an increased angle, thereby causing a lifting effect on the lower side, 1485
but there is at the same time, in addition to the acceleration on the high side, in turning on a vertical axis, there is also a tendency for the higher side of the machine to climb or increase its elevation, by turning the rudder toward the high side, resistance is interposed, slowing down the rotation on a vertical axis and the climbing effect is lessened and by reason of the lower side having a greater angle, this side is rapidly lifted. *But it is essential that the rear*

1486 *vertical rudder should act in combination with the side of least angle to together balance the effect on the side of greatest angle.* This is as I understand it from my scientific opinion of the matter." [Italics mine.]

Again in the course of his answer to XQ69 Mr. Hammer says:

"As I have already stated, it is my scientific opinion that *it is essential that the rear vertical rudder should be turned* so that the side nearest to the aeroplane receives the pressure of the air upon it and acting in
1487 cooperation with the side of least angle *to counterbalance the effect produced on the side of greatest angle.*" [Italics mine.]

Thus there is complete agreement on this point between the statements of the patent in suit, the published writings of the patentees, and the witnesses on behalf of both parties to this action, that in the Wright machine of the patent warping of the main supporting surfaces as proposed in the patent will not effect a restoration of equilibrium, unless, in conjunction with such warping, there is a movement of a vertical counterbalancing rudder device to equalize the head resistance on the two
1488 sides of the machine. Morover this so-called vertical rudder is in no sense a steering device but is an essential part of the means of controlling lateral equilibrium.

Prof. Zahm has pointed out, in his testimony in this case, that the machine of the patent in suit is not a practical gliding machine, even with this provision for simultaneous operation of the wing warping and vertical rear rudder devices. The reasons which he gives for this opinion I understand to be as follows:

The machine while gliding derives its support

wholly from the pressure of the air against its 1489
wing surfaces. This support, however, depends upon the velocity with which the wings are moving with respect to the air and upon the angle at which the latter are presented to the rush of air. If the velocity decreases, this angle of incidence must increase in order to provide the necessary support. Since, however, the wings themselves are warped to maintain lateral equilibrium, the retarding effect which is experienced by the machine in advancing through the air will vary with the angle at which the machine as a whole meets the air, and *the difference in resistance between the two sides,*
for which the vertical rudder must compensate, 1490
accordingly *varies greatly with the angle of incidence. The resistance produced by a* given movement of the *vertical rudder,* however, *does not change with alterations in the angle of incidence* and hence there is a constant effect of the rudder for a given extent of wing warping, whereas such wing warping produces different degrees of unbalancing according as the angle of incidence varies.

It does not require expert knowledge of this subject to see that this is and must be true and that if the co-ordination of movement of the rear
rudder to the wing warping movement is correct 1491
for one angle of incidence, it cannot be correct for any other, but that, on the contrary, there must be a large difference between the counterbalancing force required as the angle of incidence varies from small to large angles. Since, as I have above shown, it is agreed by everyone that the unbalanced resistance of the two sides of the aeroplanes when in warped condition must be corrected in order to preserve equilibrium, it is evident that equilibrium under changing angles of incidence, such as the record shows continually

1492 occur, cannot be maintained with the structure of the patent. I state this as a necessary deduction from the statements of the patent and the universal agreement of authorities on the correctness of the proposition, and not on my own authority. Prof. Zahm, however, states the matter as a conclusion from his expert knowledge of both the theoretical and practical aspects of the art, and I point out that this is a necessary deduction from the state of facts agreed to by all of those having expert knowledge of the subject.

It is evident, therefore, from the face of the
1493 patent and from the compelling agreement therewith of all those speaking authoritatively upon the subject that the machine of the patent is in Prof. Zahm's ~~works~~ words "dangerous and inoperative for purposes of practical flight." I find this confirmed in a positive and direct manner by the statements of the Messrs. Wright in evidence and by the changes in construction which the record shows had to be made in the machine of the patent before a practical flying machine was attained. First, as recalling again to the mind of the Court the attitude of the patentees them-
1494 selves toward the art in the first instance, I quote the following from Defendant's Exhibit "Turner Article," pages 444 and 445 as follows:

> "In 1896 we saw a little press despatch in a newspaper telling of the death of Lilienthal by a fall from his machine. This, and the reading of the 'Aeronautical Annual' for 1897, started our first active interest in the problem of aerial navigation. We have been at work at it ever since: first as a mere scientific pastime, but

for nearly ten years as the most serious 1495
purpose of our life. Up to 1900 we had merely studied and made laboratory experiments; in that year we started actual experiments in flying on our gliding-machine.

At that time (1900) there was really only one problem remaining to be solved to make a workable flying-machine—the problem of equilibrium. Men already knew how to make aeroplanes that would support them when driven through the air at a sufficient speed, and there were engines light enough per horsepower to pro- 1496
pel the aeroplane at the necessary speed, and to carry their own weight and the weight of an operator. There were plenty of aeroplanes that would fly in still air. What was needed was an air-ship that would not capsize when the wind was blowing."

In other words this statement says that the mere fact that gliding flights were possible with a machine, does not make it a practical machine. In fact there were plenty of aeroplanes that would fly in still air, and indeed, the record shows that 1497
all who had previously flown had in general accomplished their flight against moderately strong winds, which so far from being a disadvantage were an actual advantage so long as they were steady and the aviator flew directly into them. It was unsteady winds and cross winds which were dangerous, and it is for such conditions, as I understand the matter, that the patentees held that "the problem of equilibrium" was one "remaining to be solved."

1498 Turning now to the Defendant's Exhibit "Wright Brothers Article in Century Magazine for September, 1908," I find what seems to be in effect the published testimony of the Wright Brothers themselves, that the machine of the patent in suit did not in fact solve this problem of equilibrium. On page 649 of this exhibit I find the following statements:

> "We had not been flying long in 1904 before *we found that the problem of equilibrium had not as yet been entirely solved.* Sometimes, in making a circle, *the machine would turn over sidewise despite anything*
> 1499 *the operator could do,* although, under the same conditions in ordinary straight flight it could have been righted in an instant. * * *
>
> The causes *of these troubles*—too technical for explanation here—*were not entirely overcome until the end of September, 1905.* * * *
>
> *A practical flyer having been finally realized,* we spent the years 1906 and 1907 in constructing new machines and in business negotiations." [Italics mine.]

1500 As I understand this it is a statement that while, like the machines of the prior art, the machine of the patent in suit could glide under favorable conditions, it was not a practical and operative machine, and just as these prior machines were held by the Wright Brothers not to solve the problem of equilibrium, so this machine of the patent in suit did not solve it. As Prof. Zahm says (answer Q62):

> "Such a machine while physically capable of being navigated in both recti-

> linear and curvalinear flight, when handled 1501
> with due skill and precaution in favorable
> atmospheric conditions would be dangerous
> and inoperative for purposes of practical
> flight."

In other words, the machine of the patent in suit is not an operative machine in the practical sense but, on the contrary, according to the patentees themselves, speaking in 1908,

> "The machine would turn over sidewise despite anything the operator could do."

I understand, therefore, that it is agreed that 1502
the machine of the patent in suit is not a practical gliding machine, and also this conclusion follows from the statements of the patent in suit and of all those who speak from expert knowledge of the matter, as shown above.

It appears from the evidence in this case that among the essential changes which had to be made before the problem of equilibrium was solved in 1905, as appears from the above quotation, was the provision of means whereby in effect the point of attachment of the rudder ropes 27 to the warping rope 19 could be changed by the oper-
ator without however altering the simultaneous 1503
operation of the two by one controlling means moved by the operator. By this change the operator was enabled to cause the rear rudder to move to a sufficient extent to compensate for the large changes in counterbalancing force required by the changing angles of incidence in practical flight.

Recess for Lunch.

1504 The difference between the combined warping
and vertical compensating rudder control of the
machine of the patent and that of the "practical
flyer * * * finally realized," can be seen
by comparing the drawings of the patent in suit
with Defendant's Exhibit "Drawing Present
Wright Warping Lever." It will be seen from a
comparison of these that the cradle of the patent
has been entirely abandoned, and that the control
is affected by a vertical lever A which is operated
by the operator seated on a suitable seat provided
instead of lying prone upon the lower wing.
This lever A, rocks two sectors D, one of which
1505 is connected to the rudder chains and the
other to the warping chains. When the lever
A is moved both of these sectors and chains are
operated so that the wings are warped and
simultaneously the rudder is turned. The warp-
ing sector, however, is fast upon the lever shaft
as shown in Fig. 3, while the rudder controlling
sector is loose upon the shaft but is held to
a normal relation therewith by a spring as
shown in Fig. 1. The exact relation of this
sector to the warping sector is controlled by a
rod or tube extending upward to a handle or
1506 secondary lever B, pivoted at C at the top of
the lever A. By tilting this handle B the re-
lation of the rudder controlling sector to the
warping ropes is altered, this being as will be
evident similar to an alteration of the point of
attachment of the rudder ropes 27 of the patent
to the warping rope 19. By this means the large
differences in the required counterbalancing ef-
fort, resulting from different angles of inclina-
tion, can be sufficiently compensated for, so that
it is no longer true, as stated of the machine
of the patent, that "the machine would turn over
sidewise despite anything the operator could do."

As I understand the matter this difference in 1507
mechanism exemplified by the drawing "Present
Wright Warping Lever," was essential before
"a practical flyer" was "finally realized."

I have called attention to the fact that the specification of this patent in suit and the drawings thereof disclose flat aeroplanes, the only suggested departure from flatness being such curvature or bagging as might be produced by the wind. On this subject the specification says (page 5, lines 51 and following):

> "We have used the term 'Aeroplane'
> in this specification and the appended
> claims to indicate the supporting-surface 1508
> or supporting-surfaces by means of which
> the machine is sustained in the air, and by
> this term we wish to be understood as
> including any suitable supporting-surface
> which normally is substantially flat, although, of course, when constructed of
> cloth or other flexible fabric, as we prefer
> to construct them, these surfaces may receive more or less curvature from the resistance of the air, as indicated in Fig.
> 3."

It appears from the testimony of Mr. Wilbur 1509
Wright in this case that the patentees never
have tried flat planes up to the time of his giving
his testimony, but on the contrary have always
used planes constructed with a fore-and-aft
curvature imparted by curving, in a fore-and-aft
direction, the ribs corresponding to the ribs 5
shown in Fig. 2 of the patent in suit. From the
Defendant's Exhibit "Wright 1901 Address," it
appears that the 1900 machine was found to be

1510 deficit in lifting power, this deficiency being attributed, among other causes, to the fact—

> "That the depth of the curvature of our surfaces was insufficient, being only about one in 22 instead of 1 in 12."

It further appears that the machine of the following year was constructed with a fore-and-aft curvature of 1 in 12, that is to say, for every foot of cord or straight line length fore-and aft, there was one inch of bending of the rib out of a straight line, the bend occurring mostly at the front end as I understand Mr. Wright's
1511 testimony in this case. This curvature however, was found to give an uncontrollable machine the action of which is illustrated by the three diagrams X, Y, Z of Fig. 1 of this Wright 1901 Address, which shows one of the wings flown as a kite in winds of different strength. In light winds it was found that the wing tended to rise at the front end, giving an upward pull on the cord C, while with a stronger wind it gave a horizontal pull, and with a still stronger wind a downward pull. This was corrected and a satisfactory wing obtained by changing the curvature upon that shown by diagram 1 of Fig.
1512 2 to that shown in Diagram 3 of Fig. 2. Thus it is evident that the curvature of the wing is a matter of the greatest importance.

In the Defendant's Exhibit "Wright 1903 Address," it is stated that, following the experiments of 1901, laboratory experiments were undertaken for the purpose of investigating the amount and direction of the pressure produced by the wind upon various shaped surfaces exposed at various angles of incidence and in accordance with the information so obtained a machine was built for 1902 which, according to the testimony of

Mr. Wright and according to the photographs 1513
in the exhibit, also had curved surfaces. According to the testimony of Mr. Wright also, all the machines which have since been built from this early experimentation have also had curved surfaces, and it thus appears that the patentees of the patent in suit did not disclose the machine in the best form with which they were acquainted, or as an alternative to this, that they assumed that they were patenting merely a minor feature in a well known class of machine and that the art was so well informed regarding the construction and use of such machine, that
it would not be misled by showing and describ- 1514
ing the planes as flat surfaces, without curvature other than that accidentally imparted by the wind, or rush of air as the machine moves through it. In other words, as I understand the matter either the patentees concealed important information necessary to the construction of a satisfactory machine, or they proceeded on the assumption that this was a matter so well understood that even the erroneous showing of flat planes would not prevent anyone from understanding that they should be curved and that anyone would know what a suitable curvature
would be. 1515

Adjourned at 4:30 to Dec. 2, at 11:00 A. M.

New York, N. Y., Dec. 2, 1911.

Met pursuant to adjournment, at 10:45 A. M.

Present—Counsel as before.

(Witness continues.)

While on this subject I will refer to a number of statements contained in Defendant's Exhibit

1516 "Wright Brothers Article in Century Magazine for September, 1908." The article begins by reference to the machines and flights of prior aviators and mentions the fact that one principle frequently used was that of the so-called dihedral angle in which the wings are placed to one another so as to form a sort of broadened V. This principle I believe was first pointed out in the analysis of flight by Sir George Cayley in 1909. Following this, namely on page 643, the Messrs. Wright make the following statement:

> "After considering the practical effect of the dihedral principle we reached the con-
> 1517 clusion that a flyer founded upon it might be of interest from a scientific point of view, but could be of no value in a practical way. We therefore resolved to try a fundamentally different principle. We would arrange the machine so that it would not tend to right itself. We would make it as inert as possible to the effects of change of direction or speed, and thus reduce the effects of wind-gust to a minimum. We would do this in *the fore-and-aft stability by giving the aeroplane a peculiar shape;* and in
> 1518 the lateral balance, by arching the surfaces from tip to tip, just the reverse of what our predecessors had done."

I call attention to the importance in securing stability here ascribed to the "peculiar shape" of the planes in the fore-and-aft direction. Neither of these curvatures is referred to in the patent in suit, although in the "Wright 1903 Address" it is stated that they found it necessary to bring the wing tips six inches lower than in the center (p.

5). Further on in this 1908 article (page 645) 1519
I find the following:

> "The machine of 1901 was built with the shape of surface used by Lilienthal, *curved from front to rear like the segment of a parabola with a curvature* $\frac{1}{12}$ the depth of its cord; but to make doubly sure that it would have sufficient lifting capacity when flown as a kite in fifteen or twenty mile winds, we increased the area from 165 square feet, used in 1900, to 308 square feet—a size much larger than Lilienthal, Pilcher or
> Chanute had deemed safe." (Italics mine.) 1520

I note that although Mess. Wright thought this reference to shape necessary in this 1908 article, they made no disclosure as to shape in their patent in suit.

Further on, in this same article, special emphasis is laid upon the great importance of shape without, however, disclosing the correct shape, as follows (pages 646, 647):

> "*To work intelligently, one needs to know the effects of a multitude of variations* that could be incorporated *in the surfaces of flying-machines.* The pressures on squares
> are different from those on rectangles, 1521
> circles, triangles or elipses; arched surfaces differ from planes and vary among themselves according to the depth of curvature; true arcs differ from parabolas, and the latter differ among themselves; thick surfaces differ from thin, and surfaces thicker in one place than another vary in pressure when the positions of maximum thickness are different; some surfaces are

1522 more efficient at one angle, others at other angles. The shape of the edge also makes a difference, so that *thousands of combinations are possible in so simple a thing as a wing.*

We had taken up aeronautics merely as a sport. We reluctantly entered upon the scientific side of it. But we soon found the work so fascinating that we were drawn into it deeper and deeper. Two testing machines were built, which we believed would avoid the errors to which the measurements of others had been subject. After making
1523 preliminary measurements on a great number of different-shaped surfaces, to secure a general understanding of the subject, we began systematic measurements of standard surfaces, so varied in design as to bring out the underlying causes of differences noted in their pressures. Measurements were tabulated on nearly fifty of these at all angles from zero to 45 degrees, at intervals of 2½ degrees. Measurements were also secured showing the effects on each other when surfaces are superposed.

Some strange results were obtained * * *
1524 Further corroboration of the tables was obtained in experiments with a new glider at Kill Devil Hill the next season." (Italics mine.)

Although it appears that all of this work to determine the correct shape of surface was done prior to the application for the patent in suit, not a reference to it appears in the patent, nor is there any suggestion that anything but a flat plane should be used, nor that shape in fore-and-aft section is of the slightest consequence notwithstanding the statement of the article that 1525

> "To work intelligently, one *needs* to know the effects of a multitude of variations that could be incorporated in the surfaces of flying machines." (Italics mine.)

Thus the patentees, according to the statements of their own published writings, neither disclosed a practical flying machine in the sense of one capable of being maintained in lateral equilibrium, since "the machine would turn over sidewise despite anything the operator could do," nor in the sense of one having suitably shaped wing surfaces. 1526

Reverting now to the matter of engine location as an important and necessary factor in the construction of a successful dynamic flying machine, I note that there is no instruction whatever in the patent in suit as to where or how the engine should be located or how it should be controlled, and, since these are manifestly essential matters, the patent in suit, even though it disclosed a practical gliding machine (which, as I have shown above, is not true), still could not disclose a successful dynamic flyer. It appears that the prior art did not know how correctly to locate the weight of the propelling machinery in dynamic flyers. Thus Sir 1527
Hiram Maxim, who worked on much the largest scale in the construction of a dynamic flyer, thought that the driving engine should be hung very low with reference to the supporting planes in order to give stablitiy. Thus quoting from page 45 of the article entitled "Natural and Artificial Flight" by Hiram S. Maxim in the Aeronautical Annual for 1896, I find the following:

> "In regard to the stability of the machine, the *center of weight is much below the center*

1528 *of lifting effect*; moreover, the upper wings are set at such an angle that whenever the machine tilts to the right or to the left, the lifting effect is increased on the lower side and diminished on the higher side (Fig. 11). This simple arrangement makes the machine automatic as far as rolling is concerned." (Italics mine.)

I insert below a reproduction of Fig. 11 here referred to, to which I have added the letter W to designate the several wings or aeroplanes and the letter M to denote the location of the motor:

1529

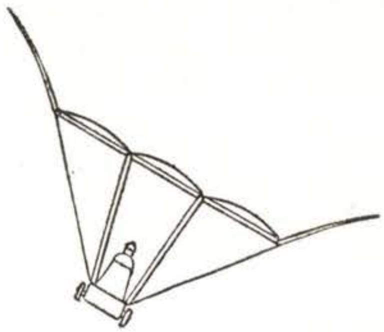


Fig. 11.

It will be noted that the weight is very far below the supporting surfaces. This, however, according to the Wright Article "Defendant's Exhibit Wright Brothers Article in Century Magazine for September, 1908," is exactly the wrong place for the power plant, since it would tend to give a pendulum effect which is destructive of stability. I quote from page 642 of this exhibit as follows:

1530

> "The balancing of a flyer may seem, at first thought, to be a very simple matter, yet almost every experimenter had found in this

the one point which he could not satisfactorily 1531
master. Many different methods were tried. Some experimenters placed the center of gravity far below the wings, in the belief that the weight would naturally seek to remain at the lowest point. It was true, that, like the pendulum, it tended to seek the lowest point; but also, like the pendulum, it tended to oscillate in a manner destructive of all stability."

Recess for Lunch.

Similarly Ader who, next to Maxim, constructed
a flying machine on the largest scale shows the 1532
boiler and engine both well below the supporting surfaces, giving a low center of gravity. Thus referring to Defendant's Exhibit L'Aeronautique Publication," Plate XII, a vertical longitudinal section of the machine is shown. As there shown the chassis of the machine is hung far below the average plane of the wings and carries the steam boiler and control apparatus while the engine hangs below the propeller shaft. Evidently in this case also the art taught that the center of gravity should be made low by suspending the motive power below the supporting curvature. This, however, the
Messrs. Wright say in the quotation just above 1533
made from their 1908 article is "destructive of all stability."

Thus the patent in suit not only confines its description to a mere gliding machine and neither shows nor describes anything else, but it does not contain any instruction as to how a suitable power plant may be constructed, located or controlled in order to transform the glider shown into a dynamic flying machine. Thus even had the patent in suit disclosed a practical gliding machine, it would have

1534 entirely failed to instruct the world how to make a dynamic flyer out of it.

As I have before noted the record shows that prior to the application for the patent in suit the Messrs. Wright had never constructed or flown a power-driven flying machine, and if the reference in the patent to flight "by the application of mechanical power" (page 1, line 14) is anything more than the formal statement of a presumption on their part that the machine might be made to fly dynamically after somebody had devised the power plant and found out where and how to install it and control it, then the patentees failed to disclose
1535 any information as to how such a result should be accomplished if they knew it, or else must have assumed that the matter was so well known that any one in the art would have known how to apply and locate such a power plant, as well as how to construct it. Thus the patentees did not disclose in the patent in suit how to construct a flying machine with a practical form of wing, did not describe how to construct a power plant, and did not disclose where to locate it or how to control it, but either concealed their knowledge or acted on the presumption that these matters were so well known to the existing art which the patent recognizes that
1536 no disclosure was necessary. Finally even as to the construction which they do disclose for the alleged purpose of maintaining lateral stability, they themselves have, as I have shown, subsequently pointed out that it did not solve the problem and that "the machine would turn over sidewise despite anything the operator could do."

I desire to state here that I intended to have said in my answer to Q2, namely that I have had no practical experience in the practical operation of man-carrying, gliding or dynamic-flying machines,

and that I also do not pretend to be highly skilled in 1537
the theory, mathematical and otherwise, of mechanical flight. I approach the matter merely as an engineer of ordinary training and experience, familiar with mechanical principles and their ordinary applications. In the foregoing answer I have therefore relied entirely upon the record and the literature of the art and have founded my statements on authority contained therein as appears from the answer.

Q5. Compare the prior art as set forth in the exhibits introduced or known to you, with the patent in suit, and state whether or not in your opinion the defendant's machine embodies the combinations 1538
set forth in Claims 3, 7, 14 and 15, or any of them, of the patent in suit, as you understand them in view of the prior art.

A. As noted in my last answer, the patentees state in their 1908 Century Magazine article, that they began their studies in aeronautics by the reading of certain literature of the art, namely, "Chanute's Progress in Flying Machines," "Langley's Experiments in Aerodynamics," the "Aeronautical Annuals of 1895, 1896 and 1897," and several pamphlets published by the Smithsonian Institution, especially articles by Lilienthal and extracts from Mouillard's Empire of the Air. This 1539
literature discloses the fact that some years prior to the initiation of gliding experiments by the Messrs. Wright, a considerable number of men had constructed gliding machines and successfully flown them, many times, covering long distances, and while two of these are recorded as having lost their lives this was the result, as pointed out by the Messrs. Wright themselves, of the defective construction of the machines, and is therefore no more evidence of failure than is the fact of the death of

1540 very large numbers of men since that time through use of the Wright machine.

The patent in suit recognizes a developed art of flying machines. This is true not only of the patent as issued but also of the specification as originally written by the Wright Brothers themselves as appears from the file wrapper. Thus on page 1, line 6 of the original specification I find the following:

> "Our invention relates to improvements in that class of aeronautical machines in which the weight is sustained by the reactions re-
> 1541 sulting when thin surfaces, or wings, are moved horizontally almost edgewise through the air."
> * * *

This corresponds to the following statement on page 1, line 9, of the patent:

> "Our invention relates to that class of flying machines in which the weight is sustained by the reactions resulting when one or more aeroplanes are moved through the air edgewise."
> * * *

These statements recognize a prior art divided into classes and confines the invention to a particu-
1542 lar class.

Along this same line the specification of the patent as issued says, page 1, line 37:

> "In flying machines of the character to which this invention relates the apparatus is supported in the air by reason of the contact between the air and the under surface of one or more aeroplanes," * * *

The original specification and the specification of the patent as issued both recognize a "usual custom" in the construction of such machines. Thus at page 5, line 6 of the original specification I find the following: 1543

> "Contrary to the usual custom, we place the horizontal rudder in front of the main surfaces or 'wings' at a negative angle and use no horizontal tail at all."

The specification as issued says:

> "Contrary to the usual custom, we placed the horizontal rudder in front of the aeroplanes at a negative angle and employ no horizontal tail at all."

Thus the usual character of the horizontal rudder in such machines is recognized but its location is said to be changed. The change in this respect, however, has been abandoned by the Wrights, as I understand, and in the last machines of theirs which I saw, the admitted "usual custom" of placing the horizontal rudder behind was followed, there being no horizontal rudder in front. 1544

The original specification recognized that forward horizontal rudders had been previously used in combination with supporting wings and a rear horizontal rudder. Thus at page 5, line 16 I find the following:

> "We are aware that a forward horizontal rudder of different construction has been used in combination with a supporting surface and a rear horizontal rudder," * * * 1545

The patent as issued contains the same statement in the same words.

The original specification also contained a further recognition of the prior art which, however, does not appear in the patent as issued. This I find on page 7, line 8, as follows:

> "We are aware that *prior to our invention flying machines have been constructed having*

1546 *superposed wings* in combination with horizontal and vertical rudders, we therefore do not claim such combination broadly," * * * (Italics mine.)

I find from the file wrapper also that the patentees recognized not only the prior existence of flying machines, but also a class of persons skilled in the art. The file wrapper shows that the Patent Office Examiner criticised the description and claims as vague and indefinite and not understood. To this the patentees replied in Paper No. 2 correcting certain errors and explaining more fully the warping of the surfaces. They conclude their
1547 letter as follows:

> "We feel certain that any person skilled in the art would be able from the description to build a machine and understand its operation when completed."

Thus the patentees recognized the existence of an art and of persons skilled in it. It is perhaps reasonable to infer from the statements in the articles quoted in my last answer that the above recited list of publications contains the disclosure of that art as they knew it.

1548 Adjourned to Dec. 4, at 11 A. M.

New York, N. Y., Dec. 4, 1911.

Met pursuant to adjournment, at 11 A. M.

Present—Counsel as before.

(Witness continues.)

The Wright patent discloses a gliding machine, as distinct from a power-driven or dynamic flying machine. The literature of the art studied by the Messrs. Wright as noted above, contains much ma-

terial relating to the gliding art and shows that, 1549
so far from having been the first to succeed in gliding flight, the best recorded performances of the Wright Brothers in such flight were far inferior in distance and duration to the best performances of their predecessors. So much so in fact, that it seems safe to say that, had it not been for the opportune development by others, just at that time, of light weight gasolene engines, the names of the Messrs. Wright would have remained, as compared to their predecessors, merely in the catalogue of those who also glided.

As noted in my last answer the record in this
case shows that prior to the filing of the applica- 1550
tion for the patent in suit the Messrs. Wright had never constructed or flown a power-driven machine. It also shows that the patent in suit does not disclose mechanism capable of solving the problem of equilibrium and producing a practical flying machine. The patent merely shows an apparatus with which, according to the record, gliding flight had been accomplished, under restricted conditions, decidedly inferior to the best performances of their predecessors.

The fact of the matter accordingly is, as I understand it, that with the addition of later in-
ventions in the way of equilibrium controlling 1551
means and the addition of a power plant devised by others and installed in a way not disclosed in the patent, the Messrs. Wright have successfully flown, after years of experiment and training to develop the essential personal skill. It is, however, also true that prior machines of several different types have successfully flown, in power-driven flight, by the aid of the same light weight gasolene motors.

As I understand the matter, therefore, the attainment of human flight in power-driven machines

1552 is a combined triumph of the light weight gasolene motor and highly developed personal dexterity, and is not due to any one invention or discovery, either in the construction or control of gliding machines.

The literature of the art of flying is by no means all of recent date, but on the contrary scientific and accurate investigation of the conditions governing flight began at least as early as the studies and writings of Sir George Cayley in 1809, and perhaps no one has given better expression to the importance of the element of personal skill than did "Thomas Walker, Portrait Painter, Hull" in his work "A Treatise Upon the Art of Flying,"
1553 in which he said:

> "When I have seen a man sitting in a chair upon a tight rope, with a table before him, spread over with decanters, glasses, &c., and, by his dexterity alone, be able to keep himself and all his accommodations exactly balanced there while he sat smoking his pipe, apparently at perfect ease; I have been induced to consider the art of managing a flying machine, compared with such a surprising display of human dexterity, to be very simple; and see no reason why men should not become as expert in navigating
> 1554 the air as the sea."

(Aeronautical Annual 1895, page 77.)

Men have not yet become as expert in navigating the air as they have in sailing the seas, but Mr. Walker evidently had the correct idea when he ascribed to personal dexterity the fundamental position in the attainment of human flight. By its aid many men had successfully flown prior to the Wright brothers attainment of that degree of skill. With the added aid of modern light weight gasolene motors, also, the prior machine of Chanute,

with its vertical side keels, has flown, in the Voisin 1555
dynamic flyer; the machine of Boulton has flown, using the Boulton three-torque control, just as Boulton planned it, as the Curtiss machine; and the Ader flyer, simplified but still retaining Ader's principle, has flown, as a dynamic flying machine, under the name of the Bleriot machine.

To the element of personal skill, the attainment of which had, long prior to the work of the Wrights, been demonstrated as possible by such men as Lilienthal, Pilcher, Chanute, Herring, and Avery, has been added possession of a light weight power plant and human flight has become possible using various types of prior machines, but with 1556
this art of power-driven flight the patent in suit has nothing whatever to do, being confined to a gliding apparatus pure and simple and that, as the patentees have themselves since stated in their 1908 articles, lacking in means for really controlling lateral stability. This I have discussed fully in my last answer and do not here repeat. It is sufficient to note that in the absence of personal skill and a light weight power plant the Wright patent would have remained as merely a Patent Office record of interesting speculation, just as did the Boulton patent, for instance, until with the aid of these things Curtiss gave the Boulton ma- 1557
chine practical embodiment and demonstrated its capacity for flying when suitably manned and propelled.

The combination with a gliding machine of a propeller and motive power plant is, however, not mere addition, that is, these cannot be installed in any way or in any position or controlled independently of the control of the machine itself. They must be installed in the right place, in the correct manner, and with means of control prop-

1558 erly coordinated to the control of the machine itself. Furthermore they introduce new forces and bring new problems of equilibrium. As is stated in an editorial on Soaring Machines in the Aeronautical Annual for 1895, page 160:

> "After the soaring-machine is sufficiently improved, the adding of a motor—if such be found necessary—will be the adding of *a new force which will tend to throw the machine out of equilibrium;* yet the power can be applied very gradually so that we may learn to counteract the disturbance of the
> 1559 equilibrium which it causes." (Italics mine.)

On this subject the Wright patent in suit is silent. The Wright patent therefore added nothing to the art of dynamic flying. In view of these facts the state of the art is very well summed up by the following quotation, from page 168 of the above mentioned publication, as follows:

> "Since the year 1790 there have been issued by the United States Patent Office one hundred and forty-nine patents for aerial machines or parts of the same. The writer has the drawings and specifications of these bound in a single volume. A study of this
> 1560 inclines one to think that the successful flying machine of the future will be in its main features, *not a new invention, but merely a new design.* So many patents have been issued for various combinations of aeroplanes and screws and for wings of different kinds, that in future it will probably be the task of the designer to properly proportion and arrange the parts, and for the inventor to improve the details.
>
> For one example; the aeroplane machine with screw propulsion and with ground

> wheels for starting was patented in the 1561
> United States so long ago that the patent has now expired. The invention is public property, but so far as now known a full-sized machine of this sort has never been properly designed, and the problem of securing its dirigibility has not been solved. While undirigible, it is of no practical use, and just as there is no royal road to skating, so there is no method of learning to steer aerial machines save the experimental one.
>
> One thing is certain; if the problem of flight had been fully solved by some one unknown to us, and if that person were to 1562
> present us with a perfect flying-apparatus, that instrument would be of no more immediate use to us than the latest safety bicycle would be to the king of Dahomey, or a pair of skates to a man who had never seen ice. Bicycling, skating, walking, swimming, and flying are all movements which must be learned by practice if at all, and, moreover, the process of learning is, in each case, likely to be attended with some personal discomfort." (Italics mine.)

The two names most prominently mentioned in 1563
the literature of gliding flight are those of Lilienthal and Chanute. Both were scientific investigators and the information which they gathered has, as I understand the matter, been of immense value and indeed the foundation of the calculations necessary in the design of flying machines. Of these two men the former not only designed and constructed a machine in a number of forms, but for five years was constantly engaged in the actual flying of them and is credited by Mr. Wilbur Wright (Defendant's Exhibit "Wright 1901 Address" page 491) with having made "some 2,000 flights,

1564 in a few cases landing at a point more than a thousand feet distant from his place of starting." Mr. Chanute designed and constructed the machines with which his name is associated but was too old a man to attempt to fly them himself, and according to Defendant's Exhibit "Gliding Experiments" they were flown chiefly by Mr. Herring and Mr. Avery, although it is stated that the machines finally became so manageable that many different persons accomplished successful flights with them.

Adjourned at 4:45 P. M. to tomorrow, Dec. 5,
1565 at 11 A. M.

New York, N. Y., Dec. 5, 1911.

Met pursuant to adjournment, at 11 A. M.

Present—Counsel as before.

(Witness continues.)

No true conception of the state of the art can be had which fails to take into consideration the state of knowledge of physical laws and the prevalence of misinformation which existed at the earlier dates considered. The art of aeronautics was pe-
1566 culiarly hampered by erroneous understanding of physical laws promulgated by prominent scientists. For instance probably the greatest handicap to the development of the art was the publication by Newton of his supposed law of air pressures on oblique surfaces which indicate, only one-tenth to one-twentieth the pressures which are actually found to exist. On this basis the mathematician Napier had calculated that it was impossible to ever produce structures and motors light enough for human flight, and in accordance with which, in order to explain the flight of birds, physical

strength had to be assigned to these natural flyers, 1567
which it is now known they do not possess.

A French scientist, Duchemin, had, as early as 1836, experimentally derived a formula, since found to be quite approximately correct, but the greater authority of Newton had caused it to be lost sight of, and it resulted therefore that the majority of the scientifically informed looked upon attempts to realize human flight as in the same category as perpetual motion, that is to say as efforts in contravention of natural laws.

It remained, therefore, for men like Maxim, Langley, Liliental, Pilcher, Phillips, Chanute, Mouillard,
Ader and others, all men prominent in the scien- 1568
tific or engineering world, to demonstrate the erroneous character of supposed knowledge and show that earlier thinkers and investigators, like Sir George Cayley, Walker, Henson, Duchemin, Stringfellow and others, were correct in their belief in the supporting power of the air. Penaud had indeed built and flown small dynamic flying machines as early as 1872, which attracted much attention, while still earlier Wenham had shown the sustaining power of wings cutting the air at small angles to be much in excess of one pound per square foot, by investigations employing both large and small wing
surfaces, so that these and others had already thrown 1569
doubt upon the accuracy of Newton's law. These results doubtless afforded encouragement to the men just mentioned, but at any rate, long before the Wright brothers entered the art, Lilienthal and Chanute, and the others whose names are associated with theirs had, proven the possibilities of human flight and developed the art of gliding to a point which apparently has not since been surpassed. Langley also had built purely automatic machines of less than man-carrying dimensions which,

1570 equipped with mechanical power, had flown to distances considerably over half a mile.

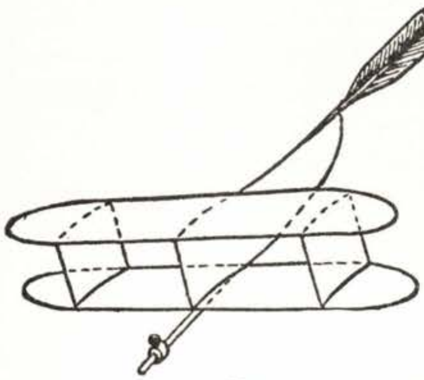
Recess.

The record shows that Lilienthal's earlier flights were made with a machine what would now be called the monoplane type, substantially like that illustrated on page 444 of Defendant's Exhibit "Turner Article" and in Figs. 22 and 23 of Defendant's Exhibit "Gliding Experiments." It comprised a pair of wings approximately in the same horizontal plane. The idea occurred to Lilienthal, however,
1571 of using two superposed surfaces constituting, in other words, what we would now designate as the biplane type. In an article entitled "Practical Experiments for the Development of Human Flight," published in the Aeronautical Annual for 1896, page 14, Lilienthal says:

> "The smaller the surface extension of the apparatus is, the better control I have over it, and yet if I employ smaller bearing surfaces in stronger winds, the results are not more favorable. The idea therefore occurred to me to apply two smaller surfaces, one above the other, which both have a lifting
> 1572 effect when sailing through the air. Thus the same result must follow which would be gained by a single surface of twice the varying capacity, but on account of its smaller dimensions this apparatus obeys much better the changes of the center of gravity.
>
> Before I proceeded to construct these double-sailing machines, I made small models in paper after that system, in order to study the free movement in the air of such flying bodies and then to construct my apparatus on a large scale, depending on the results thus obtained. The very first experi-

ments with these small models, the form of which may be seen in Figs. 1 and 2, surprised me greatly on account of the stability of their flight." 1573

I reproduce below the Fig. 1 referred to, which sufficiently shows the paper models referred to.



1574

FIG. 1.

Lilienthal did not follow very closely the form shown in this model, but did so approximately as appears from the cut on page 490 of Defendant's Exhibit "Wright 1901 Address," but Chanute followed it very literally in constructing the one of his machines which proved particularly successfull. This is shown in Fig. 229 of Defendant's Exhibit "Gliding Experiments," and the same 1575
machine without the side keels is also shown in flight in Figs. 230, 231, and 236 to 242 of the same exhibit. This same form of machine, with an increase in the vertical keel surface and a power plant applied, is the Voisin machine which flies sucessfully without other means of producing lateral 'stability than these vertical keels which Lilienthal and Chanute employ.

1576 This little paper model of Lilienthal seems indeed to have been the prototype of the modern biplane taken by the Wright brothers as developed by Chanute. To it the Wright brothers added their peculiar combined rudder-turning and wing-warping device to constitute the machine of the patent in suit, and Curtiss also followed the same model in the construction of his machine involved in this controversy, having applied thereto the Boulton three-rudder or three-torque control system of the Boulton British patent 392 of 1868.

The Wright machine of the patent in suit thus
1577 comprised this biplane structure of Lilienthal's model and Chanute's full-sized gliding machine, except that it is constructed with flat wing surfaces, and has added to it the Wright mechanism for simultaneously warping the entire wing surfaces, so as to give a minimum angle of inclination to the wind at one extremity, gradually increasing to a maximum angle at the other extremity, and the so-called vertical rudder moved to compensate the resistance to forward motion on the side having the least angle of inclination. These devices together with the front horizontal rudder of the patent (since abandoned in favor
1578 of the rear horizontal rudder of Lilienthal and Chanute) constitute the additions in the way of mechanism made by the Wrights to the prior machine, while under the head of structural changes may be classed the showing of flat planes and the mechanical details of the truss work, permitting the warping of the surfaces without decrease of their supporting strength.

Having already described in detail the warping wings shown in the patent and the inter-connected vertical rudder-moving devices I will not repeat but will here call attention particularly to

the fact that the wing-warping means constitute 1579
not only the means for maintaining lateral equilibrium when used in connection with the vertical rudder, but also constitute the only means of steering the machine in a horizontal plane. As the patentees themselves pointed out in the prosecution of their application in the Patent Office, the vertical rudder is a compensating device pure and simple and is "in no sense a steering device." Thus in amendment A, paper No. 5, dated July 11, 1904, they say, seeking to overcome the effect of prior patents showing vertical and horizontal rudders:

> "As to the vertical rudder, it is in no 1580
> sense a steering device, but is simply for correcting the increased resistance offered by one end of the machine over the other arising from the different angles at which the ends of the planes are presented to the wind and this it does automatically in a manner nowise suggested by any of the references, * * *"

The machine of the patent is, therefore, provided with no means for steering, except the warping of the wings, and concerning this warping the original specification said that it was 1581
"for the purpose of restoring the lateral balance of a flying machine and guiding the machine to right or left" (original specification, page 7). Concerning this steering of the machine to the right or left by the use of the wing tips it is shown by the statements of Mr. Wilbur Wright as contained in Defendant's Exhibit "Extract from Wright Affidavit in this Case," that so far from acting as a steering rudder, the turning of the machine of the patent in suit was accomplished in the opposite direction to that in

1582 which the rudder was turned, and that in fact steering of the machine was only possible at all by virtue of the imperfection in the correcting power of the rudder which permitted the machine to tilt and skid around, instead of turning after the manner of a boat responding to a steering rudder. Mr. Wright says:

> "It is true that the machine was not turned to right or left by using the rear rudder as a boat's rudder is used, but by warping the wings the whole machine could be given a lateral inclination and
> 1583 caused to slide off to right or left according as the right or left wing was lower than the other. In circling it was necessary to set the inner wing to a larger angle of incidence than the outside wing, because it moved in a smaller circle than the outside wing and of course had less speed. The inside wing therefore had a greater resistance than the outside wing and tended to fall behind and the machine swung around the circle with the rear rudder set over toward the outside wing and receiving a pressure on the side toward the
> 1584 outside wing a condition exactly opposite from what would have existed if the rudder had been a mere steering device."

It is evident that, if the description of the patent is correct, this steering action occurred by virtue of the impossibility of producing a structure such as is shown in the patent in suit, which, for all angles of incidence and all velocities, will enable the rudder to counteract the unbalanced pressure on the two sides with a sufficient degree of accuracy. It is evident that under such circumstances the machine would,

as Mr. Wright says, glide in circles, and no 1585
doubt it often glided in such circles when they
least desired it and were glad to escape with-
out catastrophy.

However this may be, the matter which I
desire particularly to point out is that so far
from being a steering device the so-called vertical
rudder of the patent is a pressure-balancing de-
vice pure and simple, and that the patent was
granted on the express declaration of the pat-
entees that such so-called rudder was "in no sense
a steering device." The only steering device
which the machine of the patent possesses is the
warping of the wings, and the only lateral bal- 1586
ance devices which it possesses are the means for
warping the main supporting surfaces and si-
multaneously turning the vertical rudder.

Adjourned at 4:30 to Dec. 6, at 11 A. M.

New York, N. Y., Dec. 6, 1911.

Met pursuant to adjournment, at 11 A. M.

Present—Counsel as before.

(Answer continued.)

Looking at the prior art as disclosed in the 1587
patents I find exemplified therein each of the
various plans which I have previously referred
to as having since become practically operative,
as well as others which apparently have not as
yet been used, and I find that many of the
inventors have proceeded upon the assumption
that at some time a power plant would be
devised light enough to be available for flying
machine purposes and have indicated such power
plant in a diagrammatic way. Others show only
gliding machines, while still others despairing

1588 of light weight motors have shown, in addition
to the aeroplane balloons or lighter than air
devices designed to partly relieve the planes of
the burden of supporting the weight of the machinery.

Under these circumstances no very rigid classification of the art is possible. I will, however,
roughly classify the patents and publications to
which I refer. As examples of aeroplanes guided
by vertical and horizontal rudders and maintaining their stability laterally by vertical keels,
the practicability of which has been demonstrated
by the Chanute and Voisin machines, I will
1589 refer to the British patents to Henson No.
9478 of 1842 and Lanchester No. 3608 of 1897.
As an example of machines guided by vertical
and horizontal rudders and relying upon the
dihedral angle for lateral stability after the
manner of the machines of Langley, which flew
for long distances as already noted, I will refer
to two patents to Maxim No. 16883 of 1889 and
No. 19228 of 1891. For the sake of completeness
I will refer to a single example of the combined
balloon and aeroplane type, making use of the
Crepar patent No. 588,556. As examples of machines obtaining lateral equilibrium, or steering,
1590 by ailerons or lateral rudders such as employed
in the Curtiss machine involved in this controversy I will refer to Boulton British patent No.
392 of 1868, Harte British patent 1469 of 1870,
Mouillard patent 582,757, Johnston patent 722,-516, and Defendant's Exhibit "Mattullath Application." As an example of structures of the
Bleriot monoplane type, I will refer to the Ader
machine as disclosed in Defendant's Exhibit
"L'Aeronautique Publication," and possibly also
to the Huffaker Article, which I have already
called attention to in my last answer.

Considering the class of machines having ver- 1591
tical keels I will refer first to Henson British
patent No. 9478 of 1842 which is, in many respects, a most remarkable document in that it shows a carefully worked out machine, designed by an engineer, as appears from the patent, containing many of the features of successful monoplane structures of the present day. Referring to the drawings of the Henson patent, the general scheme of the framework is shown in Fig. 1, while Figs. 2 and 3 show top and bottom views respectively of the completed machine, and Figs. 4 to 11 show mechanical details such as
the trussing of the wings, the fore-and-aft arched 1592
ribs of the wings, the hollow spars, and the methods of making and tightening the wire connections. As will be seen, the machine comprises a pair of wings curved in a fore-and-aft direction trussed by wires and vertical posts above and below as in modern monoplane construction. These are mounted upon a car or framework having landing wheels and not unlike structures recently described as having been built abroad by Bleriot. To the rear extends a horizontal tail, similarly trussed, as shown in Figs. 1 to 3, and movable about a horizontal axis being con-
trolled by two wires T, T, attached to posts P, 1593
extending above and below the tail like the ordinary rudder yoke, these wires being carried over the usual form of steering drum U, all as shown in Fig. 1. Beneath the horizontal tail as shown in Fig. 3 (which is a bottom view) is a vertical rudder Z, having a rudder yoke Z′ to which the rudder ropes are attached, these being described as carried into the car for control by the operator.

Adjourned at 4:30 P. M., to Dec. 7, at 11:00 A. M.

1594 New York, N. Y., Dec. 7, 1911.

Met pursuant to adjournment, at 11 A.M.

Present—Counsel as before.

(Witness continues.)

The planes, tail and rudder are covered with oiled silk and means are provided for contracting or furling the plane surfaces and the tail to reduce the wind resistance when the machine is standing.

A pair of propellers is provided and a steam engine is described for operating these.

Above the machine and between the two upright
1595 truss posts or masts a vertical keel is provided which is described as facilitating the lateral steering of the machine by counteracting the tendency to skid. This is like the vertical keel surfaces of the successful Voisin machine and the Chanute two-surfaced machine with side keel shown in Fig. 229 of Defendant's Exhibit "Gliding Experiments." Prof. Zahm testifies, from his expert knowledge of flying machines in practical use, that this keel or dorsal fin is adapted to give automatic lateral stability and to steady the aeroplane above a vertical axis.

Henson directs that there should be about one
1596 square foot of surface in the wings and tail combined for each half pound weight of the machine, including machinery and load. I note from Defendant's Exhibit "Wright 1903 Address" that the gliding machine there described had about 320 square feet in the planes and horizontal rudder, and that the weight with the operator was from 250 to 260 pounds. Thus Henson provided an ample amount of surface for the support of the machine in the air at low speeds.

Recess.

It had been shown by Sir George Cayley as early as 1809 or 1810 that the center of pressure on a

plane exposed to the wind shifted forward when 1597
the plane was inclined at an angle. Henson corroborates this as a result of his own experiments and locates the heavy machinery in advance of the median line of the planes. He says:

> "the outline shows the position of a steam boiler and engines for giving motion to the propelling machinery hereafter explained, such engine and boiler being fixed rather forward in the car or vessel, because from experiment I have found it desirable that the weight carried by such a description of locomotive machine
> should be forward;" 1598

Thus Henson locates the center of weight forward of the center of the planes to correspond with the shifting forward of the center of pressure.

The manner in which Henson introduces his description is interesting and I quote it as follows, beginning at line 14, page 2:

> "I will first shortly explain the principle on which the machine is constructed. If any light and flat or nearly flat article be projected or thrown edgewise in a slightly inclined position the same will rise on the air till the force
> exerted is expended, when the article so thrown 1599
> or projected will descend; and it will readily be conceived, that if the article so projected or thrown possessed in itself a continuous power or force equal to that used in throwing or projecting it, the article would continue to ascend so long as the forward part of the surface was upwards in respect to the hinder part, and that such article, when the power was stopped, or when the inclination was reversed, would descend by gravity only if the power was stopped, or by gravity aided by the force of power contained in the article, if the power

1600 be continued, thus imitating the flight of a bird.

Now, the first part of my invention consists of an apparatus so constructed as to offer a very extended surface or plane of a light yet strong construction, which will have the same relation to the general machine which the extended wings of a bird have to the body, when a bird is skimming in the air; but in place of the movement or power for onward progress being obtained by movement of the extended surface or plane, as is the case with the wings of bird, I apply suitable paddle wheels or
1601 other proper mechanical propellers worked by a steam or other sufficiently light engine, and thus obtain the requisite power for onward movement to the plane or extended surface; and in order to give control as to the upward and downward direction of such a machine, I apply a tail to the extended surface, which is capable of being inclined or raised, so that when the power is acting to propel the machine by inclining the tail upwards, the resistance offered by the air will cause the machine to rise on the air; and, on the contrary, when the inclination of the tail is reversed, the ma-
1602 chine will immediately be propelled downwards, and pass through a plane more or less inclined to the horizon as the inclination of the tail is greater or less; and in order to guide the machine as to the lateral direction which it shall take, I apply a vertical rudder or second tail, and according as the same is inclined in one direction or the other, so will be the direction of the machine."

Experience with machines of the Bleriot type (which broadly are machines of the Henson type) shows that there is nothing visionary or absurd

about the construction which Henson sets forth. 1603
It is the work of an engineer and the plan of trussing and the structural details are substantially modern. It has the curved wings, a correct location of the weights, vertical and horizontal rudders independently operable by the operator, and shows how far the art had progressed at this very early date. Any one who has been to an "Aviation Meet" and has seen a large number of machines in the air at one time cannot fail to have been struck with the great diversity of form presented by the various machines, and such a one, looking at the Henson patent, will recognize that the Henson machine would not appear in any way strange or ab- 1604
normal among these various forms.

It is interesting to note that Henson proposed to start his machine by propelling it down an incline very much as the Messrs. Wright started their machines until comparatively recently, and also that it is provided with landing wheels to prevent injury in landing. Regarding this Henson says (page 4, line 12):

> "it will be seen that the car or vessel has three wheels, in order that when the car comes to the earth, it may run freely without injury, and owing to the great control which the tails 1605
> offer in governing such a machine in descending, the car may be caused to come to the earth in so flat an incline that in taking the earth very little, if any, shock will be perceived by the passengers."

As a further example of this class of monoplane machine steered by vertical and horizontal rudders and attaining lateral stability by vertical keels, I will refer to the Lanchester British patent 3608 of 1897. This structure is also the work of an engineer and is carefully worked out. Both aerial

1606 torpedoes, which are small automatic machines like the Langley flyers, and larger machines designed to be controlled by a pilot are shown. The introductory paragraphs of the specification are as follows:

> "My invention relates to improvements in machines for the purpose of aerial locomotion and navigation, and refers more particularly to the construction of a machine specifically heavier than the atmosphere that shall be able to traverse the air in any desirable direction, either under the control of an aeronaut or otherwise.
>
> 1607 Part of the present invention has for its object to provide means whereby both the *lateral* and fore-and-aft stability of the machine is automatically secured; other portions relate to the form and structure of the supporting surfaces and propeller, and to the launching and controlling arrangements." (Italics mine.)

The general form of the larger machine may be seen from Figs. 10, 11 and 12, in which Fig. 12 is a plan view of the machine except that the left wing is broken away. Fig. 10 is a side view, while
1608 Fig. 11 is a half front view. The wings taper from the body towards the extremities and the shape of the wings in fore-and-aft section from the body towards the tip is shown in Fig. 6, in which the upper figure is a fore-and-aft section close to the body, while the three sections below it represent sections progressively farther out from the body. The planes are thus curved and are very similar to the wings of monoplanes as used at the present time. Referring to Figs. 10 and 12 a pivoted horizontal rudder is shown at the rear at *b*. To preserve lateral stability two duplicate vertical keels

c are provided at the forward end, and two similar 1609
keels *d* toward the rear end. The latter two vertical keels are arranged on vertical pivots to act also as vertical rudders as shown in Figs. 13 and 14. The specification says (page 4, line 39) that a single fin may be used of less height but of greater length as shown at *c′*, Fig. 1.

The way in which vertical keels act in flying machines to preserve lateral equilibrium is described by the patentee as follows (line 51):

> "If in the course of its evolutions a machine (constructed as hereinbefore described) heel over sideways one way or the other or if a 1610
> 'rolling' motion be set up, the first effect is for the machine to begin to slide down, so to speak in the direction in which it is for the time being inclined, this motion is very quickly arrested however by the resistance of the 'fins' whose center of pressure is arranged above the center of gravity of the machine and equilibrium is thereby restored, a similar result might be brought about by inclining the wings or the tips of the wings upwards to the right and left but an arrangement of fins is especially valuable owing to its 'damping' action on any side oscillations that may be set up." 1611

An efficient system of trussing for the wings is described and means also for manipulating the horizontal and vertical rudders. Launching ways are also shown and described.

It will be observed that both the Henson and Lanchester structures, while preserving lateral stability by means of vertical keels, as in the modern Voisin machines, are dirigible up and down and to right and left by horizontal and vertical rudders respectively, and while the horizontal rudder is at the rear, instead of at the front in both cases, this is

1612 an immaterial matter, both locations being used in modern machines, and the Wright Brothers having themselves abandoned the forward horizontal rudder in favor of what the patent in suit designates "the usual custom" of placing it in the rear. It is further to be noted that in these machines the vertical rudder acts to turn the machine to the right or left, according as it is turned in the corresponding direction just as the testimony shows that the defendant's machine is steered, and not like the so-called vertical rudder of the patent in suit which, according to the statements of Mr. Wilbur Wright several times already referred to, works in a re-
1613 verse direction from a ship's rudder. It will be remembered that the patent in suit was obtained only on the assurance that the vertical rudder of the structure of the patent is "in no sense a steering device." I understand that, on the contrary, the rudder of the defendant's machine, like the rudders of the Henson and Lanchester machines, is a steering device pure and simple, and that it is operated exactly like a ship's rudder in each of these cases.

Adjourned at 4.30 P. M. to Dec. 8, at 11 A. M.

New York, N. Y., Dec. 8, 1911.

1614 Met pursuant to adjournment; at 11:20 A. M.

Present—Counsel as before.

By Mr. Newell: As it has been impossible to get Mr. Willard back here for the completion of his cross examination, as Mr. Willard is now in Mexico, so I am informed and believe, I have just asked Mr. Toulmin whether he would agree to an extension of the time now limited for the purpose of bringing Mr. Willard on, but Mr. Toulmin says that he cannot grant the same. I therefore give notice that Wednesday morning,

December 13th, I shall move the Court for 1615
an extension for this purpose.

(Answer continued.)

It is to be noted that, whereas the Wright patent in suit shows flat planes, except as the cloth covering may be bagged by the wind, which, as I understand the matter, is a highly objectionable form of curvature because the curve changes as the center of pressure shifts, the Henson and Lanchester patents both show curved wing surfaces. It appears from the various writings of the Wright brothers in evidence, to which I have already referred, that
these gentlemen claim to have obtained, prior to the 1616
date of the application for the patent in suit, large quantities of secret information as to exactly what these curvatures should be. This, however, they did not in the patent in any way give the public the benefit of. On the contrary, unless they assumed that the public already knew everything necessary, they misled it by showing flat planes, and whatever scientific precision of surface conformation of the planes may have actually been incorporated in the Wright machines as built, apparently does not inure to the benefit of the patent, which gives no notice of any kind that curved
surfaces are required. The Henson and Lanchester 1617
patents both show curved surfaces, and Lanchester illustrates and describes them with considerable particularity, and also inserts at page 3, line 42 and following, a caution regarding the stretching of the surfaces or the varnishing of them in such a manner as to stiffen them so that bulging by the action of the wind will not destroy the proper curvature. Regarding the shape of the wings Lanchester says as follows, quoting from the several places in the specification noted below, as follows:

"The form of wing employed to support the weight of the machine is preferably that

1618 of the soaring bird, that is to say, of great lateral breadth and small fore and aft dimension with a convex upper and a concave under surface, the intensity of the curvature diminishing and the plan contour of the wing tapering towards its extremity (page 3, line 31)."

"When fabric is employed, it is preferable to arrange the fabric of the upper surface of closer texture than that of the under or a coat of varnish may be applied in order that it may bulge properly when the machine is in motion" (page 3, line 42).

1619 "The plan form is preferably elliptical or thereabouts as shown in Fig. 3 and of gradually changing sectional form towards the extremities, a series of suitable sections being shown in Fig. 6 in which the mean surface of curvature of the central section is shown as a dotted line throughout; I find it advantageous thus to diminish the steepness of curvature towards the wing extremities also to so arrange that the front edge 'dips' considerably relatively to the direction of motion which in Fig. 6 is presumed to be across the paper from right to left"

1620 (page 4, line 27).

This careful disclosure of wing curvature is in marked contrast with the silence of the patent in suit upon the subject.

It may be that, with their recognized enormous personal acrobatic skill in flying, the Wright brothers themselves can now construct and glide safely in the flat plane machine of the patent in suit, but if so it is evident that such a demonstration would be merely in the nature of a *tours de force,* and a tribute to their personal skill, rather than an evidence of the fairness and adequacy of

their disclosure to the public in the patent in suit, 1621
since the record in this case and the literature of
the art show that neither the Wright brothers themselves
nor the flyers that preceded them ever used
flat surfaces. It appears, on the contrary, that
they all used curved surfaces. It seems probable
therefor that as a matter of fact this Henson
patent and this Lanchester patent are more adequate
disclosures of practical flying machines than
is the Wright patent in suit, for these two British
patents not only show light efficient structures
adequately worked out from the engineering point
of view, together with vertical and horizontal
steering rudders independently controllable by the 1622
operator, and a method of obtaining lateral equilibrium
shown by the successful use of the Voisin
machines to be practically satisfactory and operative,
but they also disclose curved wing surfaces,
thus informing the public as to the importance of
such curvature and disclosing curves which they
believed to be suitable, instead of concealing their
information on this matter.

As an example of the work of patentees who
despaired of ever getting motors light enough to
be supported by the forward motion of planes
alone, I will refer to the patent to Crepar #588,-
556. Referring to Fig. 1 of this patent, a balloon 1623
10 is shown shaped to give easy passage through
the air by conforming approximately to the stream
line formation of air currents. From this is suspended,
or rather below it is attached, a similarly
shaped car containing the propelling machinery
and provided with aeroplanes 12. A front horizontal
rudder is shown at 17, in plan view in Fig.
4, operable from within the car to positive or
negative angles of incidence as in the case of the
front rudder of the patent in suit, and a rear
vertical rudder 22 is mounted on a vertical pivot

1624 at the rear and controlled by tiller ropes *i* leading to the same point in the car where the horizontal rudder ropes *c* also terminate. The specification points out that by the front rudder the angle of incidence of the machine as a whole is altered and the direction of the machine in a vertical plane changed. It also points out that the direction in a horizontal plane is controlled by the rear rudder.

As illustrating machines equipped with vertical and horizontal rudders and relying upon the dihedral angle of the wings or wing tips for lateral stability, I refer to Maxim patents 16883 of 1889 and 19228 of 1891.

1625 Recess.

I quote from the first of these patents as follows (page 5, line 29):

> "Numerous attempts have heretofore been made in various countries to produce a machine for navigating the air. All these attempts have failed, generally by reason of the great weight of the machine and its load in proportion to the power of the generator and motor. In some of the aerial machines heretofore devised, there is an inclined
> 1626 plane or kite which is intended to be driven forward by means of screw propellers, with such velocity that the machine will while moving forward, be raised from the ground by the action of the air upon the said inclined plane. But, in all the machines of this kind heretofore constructed (with the exception of those in which the motor consists of compressed air or of a twisted string or cord of india-rubber), the weight of the entire machine and its load in proportion to the power of the generator and motor has

> been such that the apparatus has travelled, 1627
> or had a tendency to travel, in a direction
> the reverse of that intended by the inventor,
> that is to say, downward instead of upward.
>
> In machines of this kind driven by compressed air or by a twisted string or cord of india-rubber all the energy to be used for driving the machine must be stored in the same before starting it, and as soon as this energy is expended, the machine will descend. It is evident, therefore, that such machines can only operate for a comparatively very short time."

Thus Maxim recognizes the successful accom- 1628
plishment of the construction of flying machines propelled by india-rubber and compressed air motors, referring evidently to the machines constructed by Penaud, Stringfellow, and others, but points out that engines generating power as they go along instead of being required to store it were too heavy in proportion to their power to realize sufficient support from the air. On page 15 of the specification, line 34, he says:

> "The aerial machines hitherto constructed
> have been very heavy in proportion to their
> power, having a weight of from five hun- 1629
> dred to one thousand pounds for each horse
> power of the motor. Consequently they have
> failed to rise in the air."

In contrast with this it may be noted that present gasolene engines used for such purposes weighed from two to four or five pounds per horsepower, and that according to the testimony of Mr. Curtiss in this case the weight of the machine complained of, including the weight of the pilot, was 650 pounds, or about 26 pounds total weight for each horse power. Also the early Wright machine

1630 described in Defendant's Exhibit "Letter to Aero Club," was said to have a total weight of 925 pounds including the operator and a motor of about 24 horse power, thus having about 38 1/2 pounds weight for each horse power. Thus the difference made possible by light weight motors is enormous, not only by reason of the actual decreased weight of the motor, but due to the decreased weight permitted in the construction of the machine on account of the superior lightness of the motor which it has to carry.

In describing the machine of Maxim I will refer to the second patent 19228 of 1891. The general
1631 arrangement of the machine is perhaps best seen in Fig. 4. It is seen to comprise an aeroplane curved fore and aft designated D. This is trussed above and below for strength. At the front and rear ends respectively are arranged two horizontal rudders, the arrangement in plan view being as shown in Fig. 2. Control ropes b^3 are provided connecting these rudders to one another so that they move in opposite directions at the front and rear ends respectively, and control wires b^4 are carried over suitable pulleys to a central control point C. These planes or horizontal rudders are described as maintaining the longitudinal equilibrium of the
1632 machine and steering its course in up and down directions, as in Curtiss machines at the present time.

As seen in Fig. 3 the main supporting plane is provided with movable laterally extending wing tips pivoted to the main plane and arranged to be set by greater or less dihedral angles to maintain lateral stability, this same principle being employed in the successful Langley machines, to which I have already referred, and in many present day machines, such for instance as the well known Bleriot machine. Controlling means are provided for varying the angle of these wing tips, and the specification describes automatic means which may be used for actuating them to control side-wise pitching but says that it is not always necessary to employ automatic means for so doing. The vertical rudder construction is not shown in this patent but is shown, together with the wire for turning it, in Fig. 24 of the Maxim 1889 patent. 1633

The literature of the art shows that this machine was built and operated. Maxim however recognized that he did not have the manipulative dexterity necessary to control the machine in free flight, and he therefore mounted it upon rails, there being rails upon which the wheels ran when the speed was in- 1634
sufficient to raise it from the ground, and an upper set of parallel rails, on the underside of which the wheels ran when the machine was in flight with its weight supported by the air. The literature of the art shows that the machine flew with such a strong upward pressure, against the rails constraining it from rising further, that the strain was greater than that for which the structure was designed and a rail on one side gave way and permitted the machine to be free to rise on one side, while constrained on the other. It thus turned over and was wrecked, but not until a large amount of information had been gathered as to the supporting power 1635
of the air acting against aeroplanes of various shapes, the thrust of propellers working in the air, and the resistance to motion caused by the structural parts of the machine.

There is thus disclosed a machine controlled by vertical and horizontal rudders there being two horizontal rudders manipulated reversely, as in the modern Curtiss machines. The machine also has curved aeroplanes, or supporting surfaces and obtained its lateral stability by adjusting the wing tips to suitable dihedral angles.

1636 I will now pass to patents illustrating machines making use of lateral rudders such as are referred to in this record as ailerons. Some of the patents to which I shall refer show these lateral torque producing rudders in refined form capable of use without alteration, as has been demonstrated by evidence of such use produced in the record.

I will first refer to patent to Johnston No. 722,516, application filed Oct. 18, 1894, for a so-called air-ship. The drawings show a machine provided with inclined aeroplanes C, and also partly supported by elongated gas-holders
1637 H. At one end of the machine is shown a vertical rudder D^3 for steering, provided with tiller ropes *d* leading to the point of central control. There is also a hinged horizontal rudder, or elevation regulator, L, operated from the central point of control by rudder ropes *l*. At each side of the horizontal rudder there is located a horizontally hinged blade or aileron, and these, the specification says, are controlled to maintain the lateral equilibrium. I quote the following from the specification (page 2, line 33):

> "At each side of the regulator L are smaller horizontally hinged blades L′, which
> 1638 are also under the control of the engineer and serve to elevate or depress either side of the ship, and thus aid in maintaining the equilibrium."

Whatever may be said as to the crudity or impractical character of the machine described in the Johnston patent, by way of criticism, it is in my opinion worthy of consideratton because it clearly shows the three-rudder system of control and sets it forth not as a matter of invention but merely as a natural part of the

control mechanism of a flying machine. I have 1639
called attention to it on this account. The
patentee does not pretend that there was any
inventive novelty in the combined use of a verti-
cal rudder, a horizontal rudder and lateral aile-
rons or rudders for controlling lateral stability,
and the art as I will show it by reference to
other patents shows that this was unquestionably
correct and that anyone had a right, long prior
to the date of application for the patent in
suit, to make use of a three-rudder or three-
torque system of control for controlling the mo-
tion of a flying machine about its three possible
axes of rotation. I desire to direct the attention 1640
of the Court particularly to this point, namely,
that there are three dimensions to be considered
with reference to anybody immersed in a medium
like air or water, and that all that is needed to
control the motion about either of these axes is
a rudder or system of rudders. The machine
of the patent in suit operates upon an entirely
different principle, insofar as steering for hori-
zontal control of direction and obtaining lateral
balance are concerned, since it depends upon
equalizing the resistance to forward motion on
opposite sides of the center and simultaneously
produces a greater climbing angle of the support- 1641
ing wings on one side than on the other. The
three-rudder system of control is different from
and antithetical to this, according to my view, and
is merely the application of rudder control to
the three possible axes of rotation. It is because
the Johnston patent sets this forth as merely
a natural engineering expedient, and not as a
matter of invention, prior to the date of appli-
cation for the Wright patent, that I here call
it to the attention of the Court.

By way of further illustration of the use of
ailerons I call attention to British patent to

1642 Harte No. 1469 of 1870. This patent shows a machine having a wheeled chassis and provided with supporting wings or aeroplanes, one of which is shown in Fig. 5, mounted as shown in Fig. 7, so as to be capable of adjustment to varying angles both below and above the horizontal plane. At the rear edge of each wing tip is pivoted an aileron *Y* constituting a lateral marginal portion of the wing, the two ailerons being capable of movement to different angles of incidence relative to one another and to the main supporting surfaces. The specification refers to these ailerons as "flaps of the wing."

1643 The machine is driven by screw propellers and it is evident that any motive power applied to turn such a propeller will, in accordance with the principle that action and reaction are always equal, necessarily tend to rotate the whole machine around its longitudinal axis. The patentee Harte provides the ailerons *Y* for the purpose of counteracting this tendency for one wing to rise higher than the other. In other words, the ailerons are provided for the purpose of maintaining lateral equilibrium by turning one aileron up and the other down. Each aileron is mounted upon a hinged rod *h* and each is
1644 provided with a controlling lever *l*. Regarding their use the specification says (page 5, line 4):

> "The motion of the fans of the screw propeller being rotary tends to give a rotation to the whole machine in the opposite direction. This I counteract by means of the flaps of the wings, each of which acts upon the principle of a ship's rudder, and their combined action is such that when one flap is turned up and the other down, they simply counteract this

> tendency of the machine to rotate and keep 1645
> it steady."

The specification points out that since these ailerons or flaps are independently controllable, they may also be used to turn the machine up or down, or by setting them to cause unequal resistance to forward motion they might be used for steering horizontally. Regarding this the specification says (page 5, line 10):

> "When both flaps are depressed the machine will descend, when both are equally raised it will ascend, and when both are
> raised but unequally the machine will 1646
> make a curve towards the side on which the flap is most raised."

Thus this inventor possessed the most complete understanding as to the effects produced by varying the angle of incidence of surfaces attached to the wing tips. He knew that they might be used for securing lateral balance, for changing the pitch or inclination of the machine, and for producing unequal head resistance so as to cause the machine to swerve. The longitudinal balance of the machine is provided for by what the patentee calls the "balancing beak,"
being a hinged weight *b* capable of adjustment to 1647
maintain the center of gravity in proper relation to the center of pressure The patentee apparently contemplated the use of a steering rudder and even suggests the connection of such a rudder with the aileron-controlling levers, but this arrangement is not fully described. The specification says (page 3, line 2):

> "At the end and back or hinder part of each wing is a flap which moves up and down upon a hinge in the back edge of

1648 the wing. This hinge is prolonged in the shape of a rod, and this rod is in connection with a lever, by means of which the flap is made to *rise above* or *fall below* the rest of the surface of the wing, this lever being in connection with a second lever which is within reach of the person who steers the machine." (Italics mine.)

Adjourned at 4:30 P. M. to Dec. 9, at 11:00 A. M.

New York, N. Y., Dec. 9, 1911.

1649 Met pursuant to adjournment, at 11 A. M.

Present—Counsel as before.

(Witness continues.)

It seems to me that there can be no question about the fact that the mere mention of steering is sufficient to bring to the mind of any one, whether skilled in the art or not, the suggestion of a vertical rudder, while in this art the use of vertical rudders for steering was common.

I call attention to the fact that in the Harte structure, as in the Curtiss structure involved
1650 in this suit, lateral balance is affected by moving the ailerons simultaneously in opposite direction, thereby preventing any unequal side pressure tending to alter the direction of machine. It is shown by the testimony in this record that the use of the ailerons in the Curtiss machine, for any and all conditions of flight, does not produce any detectable turning effect altering the direction of flight. This is the operation described by Harte. In the Harte patent the ailerons are attached to, and in some sense a part of, the wings or main supporting surfaces and constitute

inclinable wing tips, thus coming within the description of the Wright patent in suit if liberally interpreted and also coming literally within the description of claim 3, which calls for 1651

> "3. In a flying machine, a normally flat aeroplane having lateral marginal portions capable of movement to different positions above or below the normal plane of the body of the aeroplane, such movement being about an axis transverse to the line of flight, whereby said lateral marginal portions may be moved to different angles
> relatively to the normal plane of the body 1652
> of the aeroplane, and also to different angles relatively to each other, so as to present to the atmosphere different angles of incidence, and means for simultaneously imparting such movement to said lateral marginal portions; substantially as described."

The Harte structure has marginal portions to its aeroplanes which are apparently also normally flat, and these portions are moved to preserve lateral equilibrium so that in the language of
Harte, "one flap is turned up and the other 1653
down," and thus these marginal portions are capable of movement to different positions above or below the normal plane of the body of the aeroplane and about an axis transverse to the line of flight. Moreover, the Harte specification requires that one flap be turned up and the other down with reference to this normal plane so that they make different angles relatively thereto and to one another, and thereby present to the atmosphere different angles of incidence. Moreover levers are provided for simultaneously pro-

1654 viding such movement to said lateral marginal
portions, substantially as described in the Wright
patent if this patent includes the turning of,
surfaces attached to the aeroplane, as distin-
guished from a warping or helicoidal twisting of
the whole aeroplane.

In contradistinction to this Curtiss uses entirely separate ailerons not a part of or attached to the aeroplanes or wing surfaces. They are literally mere rudders exactly such as are shown in the Johnston patent 722,516, above referred to.

The fact should be particularly noted that Claim
3 does not require any devices imparting dirigi-
1655 bility, that is, neither horizontal nor vertical rud-
ders are recited in it. Indeed on the testimony
of the patent itself and the further testimony of
the Wright Articles in evidence, Claim 3 describes
an entirely inoperative structure if carried out
with the mechanism of the Wright patent itself.
It cannot be too strongly emphasized therefore
that Claim 3 if interpreted to describe an operative
structure must describe and include a structure
like that of Harte and does not and cannot de-
scribe the structure shown in the patent in suit it-
self, unless it is limited by the specification to
the use of a vertical compensating rudder operated
1656 in conjunction with the warping of the wings in
a manner the reverse of a steering rudder, and even
this will not make a practical and operative struc-
ture because, as pointed out by Messrs. Orville
and Wilbur Wright in Defendant's Exhibit
"Wright Brothers Article in Century Magazine for
September, 1908," they did not solve "the problem
of equilibrium" until "the end of September, 1905."

Under these circumstances it seems to me that no one but the Court can determine what Claim 3 means, although no one at all acquainted with

the art will have any difficulty in understanding 1657
what it says. It is apparently certain, however, that if it designates any operative means of maintaining lateral control, it means the Harte structure and does not mean the structure of the patent in suit itself unless limited to a machine also having cooperatively attached to the wing-moving mechanism, in a manner not discovered by the patentees themselves "until the end of September, 1905," a vertical compensating surface or so-called vertical rudder. The Messrs. Wright have publicly recognized that they did not have "a practical flyer" until the end of September, 1905, for
immediately following their explanation that the 1658
problem of equilibrium was not solved up to this time, they say:

> "A practical flyer *having been finally realized,* we spent the years 1906 and 1907 in constructing new machines and in business negotiations." (Italics mine.)

Had they used the Harte ailerons instead of warping their wing surfaces, the patentees would have had a practical means of controlling lateral equilibrium as is shown by the fact that the successful Farman flying machine uses these Harte
ailerons attached to the rear edge of the wing 1659
tips. In other words, the Messrs. Wright took the Chanute two-wing surface glider and twisted its wings in the endeavor to obtain lateral equilibrium and failed, until, more than two years after filing the application for the patent in suit, they discovered means for so coordinating a vertical compensating rudder as to secure the desired results. Farman, on the other hand, merely took the Chanute structure as a mounting for the Harte ailerons of British patent 1469 of 1870 and succeeded, for the obvious reason that by turning one

1660 aileron up and the other one down, he produced a lateral torque about the longitudinal axis without producing the disturbing torque about the vertical axis which the warping of the planes gives rise to.

I call attention to the fact that if Claim 3 of the Wright patent in suit is to be read with the meaning which it seemingly ought to have, in view of the specification and in view of the proceedings in the Patent Office, the "different angles relatively to the normal plane of the body of the aeroplane" do not mean that one wing is given a negative and the other a positive angle of incidence with respect
1661 to the rush of air as is the case in the Harte patent. These words merely mean that the positive angle of incidence on one side is increased and that on the other decreased, when applied to the Wright structure. It is for this reason that the Wright structure as defined in Claim 3 is inoperative. A glance at Defendant's Exhibit "Sketch #1" approved by complainant's expert, See, as correctly representing what happens in the Wright machine when the operation referred to in Claim 3 is carried out, will make this matter obvious at once. It is therefore questionable whether the words "different angles relatively to the normal
1662 plane of the body of the aeroplane" in claim 3, which in the patent merely mean different negative angles of incidence, can be read as including a structure which should be described as turning its ailerons to "equal positive and negative angles relative to the air rush," particularly in view of the fact that this changes the description in a way making it include a successful apparatus instead of an unsuccessful one. This, in other words, is the difference between failure and success.

Moreover, in rewriting their specification while prosecuting the case in the Patent Office and under

date of August 15, 1905, the patentees endeavored 1663
to broaden their description in this direction, but were not permitted to. This statement, sought to be inserted in the specification, reads as follows:

> "For instance, it is not necessary that the entire body of the aeroplane should be distorted in the manner described, since separate sections of the aeroplane at the sides thereof may be made movable relatively to the main bodies or normal planes of the aeroplane, and the transverse axes around which these movements occur may be located either at the front or rear of the machine, or any
> suitable intermediate point." 1664

The patentees were not allowed to make this insertion, and if they had been it would of course read directly on the Harte structure. Similarly Claim 3 unless limited to the warping of the wing surfaces, as shown in the patent and more fully illustrated in Defendant's Exhibit "Sketch No. 1," also includes the Harte structure. The Curtiss structure is different from either, being merely the Chanute machine with lateral rudders added to it, which rudders have nothing whatever to do with the supporting surface. The Harte structure, however, 1665
stands between the Curtiss structure and that of the patent in suit, and of course the Curtiss structure is much less remote from the Harte structure than it is from the Wright structure of the patent as defined in Claim 3.

Recess.

Before leaving the consideration of the Harte patent I may note that the movable weight or "beak" in front for determining longitudinal coin-

1666 cidence of the center of gravity and the center of support is a feature made use of at the present time, and according to the literature of the day is applied by the Wright Brothers themselves. Harte contemplated carrying several people, which, however, in view of the present day records, cannot be regarded as unfeasible, and the use of a depending chassis or car framework has, according to recent technical literature, been embodied in recent Bleriot machines. Harte contemplated the application either of mechanical power or muscular power, in addition to the force of gravity, and, whatever may have been the adequacy of Harte's
1667 conception in this respect, it must be remembered that the patent in suit discloses a machine without power at all or any suggestions of how to apply it, and certainly the addition of muscular power could not decrease the already minimum power of the machine of the patent in suit. Moreover, Harte shows a sane and practical location of the propelling pressure, while the Wright patent discloses none at all, and whatever may be said in criticism of the Harte patent as to practicability there is apparently no reason why with sufficient manipulative skill and scientific design, neither of which could be derived from the Wright patent, it should
1668 not successfully fly, while, on the contrary, the Messrs. Wright have in their 1908 article testified that they did not themselves attain a practical flyer until long after the application for the patent in suit and the means by which they realized a practical machine is not disclosed in the patent in suit.

I will not stop at present to compare the Harte structure with the remaining claims in issue, but will pass to the consideration of the Mattullath application. This has been so fully treated by Professor Zahm that I will refer to it only briefly.

This application correctly states that the mere 1669
fact that prior machines had not been constructed as passenger and freight-carrying machines and successfully applied, proves nothing against the feasibility of such machines, and says that enough had been accomplished prior to January 8, 1900, to demonstrate the possibility of dynamic flight upon the principle of the aeroplane propelled at an angle to the direction of flight. I refer to the first two paragraphs of the specification on page 1. Indeed it was the conviction of the truth of this statement which brought the Wright brothers themselves into the art.

The Mattullath structure comprises two narrow 1670
boat-shaped bodies united by and surmounted by aeroplane surfaces designed to encounter the wind at acute angles, two or three degrees being instanced in the specification. The boat-shaped cars are designed to house the machinery and pilot, so as to minimize air resistance, as is done in many aeroplane structures today. Mattullath's structure is provided with a vertical steering rudder Q, while for steering the machine up and down horizontal rudders O are provided arranged in two groups, one located at the forward and the other at the rear end. To preserve the lateral stability, lateral rudders C are pro- 1671
vided capable of movement about an axis transverse to the line of flight and movable to different angles relatively to the normal plane of the body of the aeroplane, and also to different angles relatively to each other so as to present to the atmosphere different angles of incidence. The use of these, like the use of the Curtiss ailerons, does not produce different resistance to forward motion as does the warping of the Wright planes, but these ailerons constitute merely rudders entirely independent of the main or supporting aeroplanes and serve to preserve the extremities of the supporting

1672 planes either in the same planes or different planes by controlling motion about the longitudinal axis, just exactly as the vertical rudder determines the motion about a vertical axis. Mattullath points out that with the existing knowledge at that time the determination of the proper amount of surface for the various parts and the pitch at which they must be set, as well as the amount of power required were, at that date, merely matters of arithmetical calculation, and that these matters could be determined before hand, but recognizing as did the editor of the Aeronautical Annual that (Aeronautical Annual, 1895, p. 168).

1673
> "One thing is certain: If the problem of flight had been fully solved by some one unknown to us and if that person were to present us with a perfect flying-apparatus, that instrument would be of no more immediate use to us than the latest safety bicycle would be to the King of Dahomey."

Mattullath pointed out in his specification that:

> "*The art of flying* with such a machine *will have to be learned*, the parts will have to be adjusted and tried, a crew will have to be trained and all this and other preliminary
> 1674 work will have to be done before actual flight can be attempted." (Italics mine.)

In other words Mattullath recognized that while he could provide *means* for determining lateral, longitudinal and vertical stability, these of themselves availed nothing, and that flying is a matter of personal skill attainable only in the school of experience. As the Editor of the Aeronautical Annual quaintly remarked:

> "The process of learning is * * * likely to be attended with some personal discomfort."

The list of 110 deaths in the last three years, to say nothing of the numerous injuries, shows that this was, to say the least, putting it mildly. 1675

If the claims of the Wright patent in issue are to be interpreted as including machines having merely a three-rudder system of control, co-ordinated, if at all, only by the skill of the pilot, I see no escape from the conclusion that they must include this structure of Mattullath, well known to those skilled in the art as shown in this record.

As further illustrating the use of ailerons I refer to the Mouillard patent 582,557, which shows a monoplane gliding machine. How fully Mouillard,
one of the acknowledged teachers of the Wright 1676
Brothers, called by them, also, one of "the great missionaries of the flying cause," understood the conditions to be met and the predominant element of personal skill is so well indicated in the introduction to the specification, that I quote the first two paragraphs as follows:

> "My invention relates to a machine for navigating the air by the force of the wind, and has for its object the imitation of the soaring of large birds, which I have been watching for thirty years, in tropical latitudes. I know from abundant personal observation that such
> birds can, without a single flap of their wings, 1677
> float up into the air on a sufficient wind, sail about at pleasure, circle and rise to great altitudes, glide down in any direction, and come back to their original starting-point upon fixed rigid wings, solely by the skillful use of the power of the wind. This I propose to imitate.
>
> It is well known that if a plane surface, or one slightly concave, be exposed to the wind at an acute angle the resulting wind-pressure will affect it in two directions. One is a ver-

> 1678 tical reaction, which lifts it up, and the other reaction either drifts it back or drives it forward, according as the surface be inclined, either below or above the horizon. It is also known that as the angle which the current of air makes with the surface is changed there is a corresponding change in the position of the center of pressure on the surface. In order to utilize these forces derived from the wind three essential requisites may be observed; first, equilibrium must be maintained under all conditions of angle of incidence and speed of translation; second, the angle of incidence with
> 1679 the wind must be changed in order that the apparatus may rise or descend; third, the apparatus must be susceptible of direction horizontally, so that it may go to the right or left, or, in other words, be steered."

Like the machine of the patent in suit the Mouillard machine is a gliding or soaring device pure and simple; one in other words with which, given sufficient personal skill, it would be possible to indulge in gliding flight.

The structure shown comprises two aeroplanes or concave surfaces joined to a central structure for
1680 supporting the pilot as the two wings of the bird are joined to its body. To give fore and aft stability the wings are pivoted so that they can be moved fore and aft, thereby expanding or contracting the tail-like portions K as a bird expands and contracts its tail, while at the same time shifting forward or back the wings themselves so as to keep the center of pressure thereof in line with the center of gravity. Looking at Figs. 1 and 2 and referring to the specification on page 2, line 93, it will be seen that each of the wing tips is provided with a flexible portion, marked respectively

J, J′. To these flexible wing tips operating cords 1681
O are attached which lead through rings P to the handles Q immediately in front of the operator as shown in Fig. 2. The two handles are separately operable to draw down the wing tips as shown in front view by Fig. 10, and by operating both simultaneously they could be set at different angles with respect to the normal plane of the aeroplane and with respect to one another. Mouillard does not describe these wing flexible wing tips as for the purpose of maintaining lateral equilibrium, but rather directs their use for the puropse of steering just as the record shows that the machine of the Wright patent in suit must be steered, if at all. 1682
Mouillard also says that both of the wing tips may be pulled down simultaneously to check the speed on alighting. Thus this machine has, in the language of Claim 3:

> "In a Flying machine, a normally flat aeroplane having lateral marginal portions capable of movement to different positions below the normal plane of the body of the aeroplane, such movement being about an axis transverse to the line of flight, whereby said lateral marginal portions may be moved to different angles relatively to the normal plane of the body of the aeroplane, and also 1683
> to different angles relatively to each other so as to present to the atmosphere different angles of incidence, and means for simultaneously imparting such movement to said lateral marginal portions."

Thus Claim 3 reads exactly upon this Mouillard structure, and if it be said that the Mouillard structure is not complete because while warping the wings only in one direction it does not furnish a vertical counterbalancing surface and so would

1684 not preserve equilibrium, the same exactly is true of Claim 3. This patent, in other words, shows that there is no novelty whatever in the combination recited in Claim 3, and since it is admitted on the face of the patent that the combination in Claim 3 is not operative, and in the acknowledged writings of the Wright Brothers that the whole machine of the patent in suit is not "a practical flyer," I am unable to see how Claim 3 can be construed to avoid the inclusion of this Mouillard structure unless limited to the precise details of the patent embodied in a practical flying machine, which interpretation would of course not only exclude the
1685 Mouillard structure, but also the more remote structure of the Curtiss machine.

I call attention to Claim 12 of the Mouillard patent, which reads as follows:

> "12. A soaring-machine having wings adapted to move in horizontal planes, a portion of the fabric covering each wing being stiffened by flexible slats and *having its rear edge free from the frame of the wing, and cords attached to said rear edge for pulling it downward*, substantially as described." (Italics mine.)

1686 I note that Mouillard gives directions as to the proportioning of the wings and points out that the life of the aviator depends upon the proper strength and proportion of parts. Regarding the amount of surface contemplated, the limiting conditions of use and the weight, Mouillard says (page 3, line 49):

> "The amount of surface of the wings should be varied in proportion to the weight to be carried and in accordance with the speed of the wind by which it is supposed to

> sail. The apparatus here shown is designed 1687 to furnish when the wings are fully opened, a surface of about one square foot to the pound of total weight (including both aviator and apparatus), this being about in the proportion of most soaring birds. The apparatus is intended to sail with winds varying between ten and twenty-five miles per hour.
>
> The weight of the apparatus will vary, of course, with the substance used in its construction, but the one shown and described should not exceed fifty-five pounds, and may possibly be reduced below that figure."

I have elsewhere called attention to the fact that 1688 one of the Wright machines described in the exhibits in evidence had some 320 square feet of surface for a total weight of 250 to 260 pounds, including the weight of the aviator, while Defendant's Exhibit "Gliding Experiments," page 608, shows that the successful gliding machine of Chanute, shown for example in Fig. 230 on the same page, had 134 square feet of supporting surface, weighed 23 pounds (or about 175 pounds with an average weight operator), and "thoroughly supported the weight of a man at speeds of about 23 miles an hour." Thus while the Wright Brothers used somewhat more than one square foot to a pound 1689 of weight in their 1902 machine, Chanute used somewhat less, and Mouillard's constructions fall between them. I may note that the Curtiss machine flying, according to Mr. Curtiss' testimony, at from 35 to 38 miles an hour, has about 234 square feet of surface on which to carry 650 pounds of weight, or only about .36 square feet per pound. The Wright patent is entirely silent as to any proportions.

Adjourned to 4:30 to Dec. 11, at 11 A. M.

1690 New York, N. Y., Dec. 11, 1911.

Met pursuant to adjournment at 11 A. M.

Present—Counsel as before.

(Witness continues.)

It will be noted that the Mouillard patent has no description of a vertical rudder. Mouillard proposed to steer with the flexible wing tips. After describing the connections to the handles for moving the wing tips, he says (page 2, line 101):

> "A pull upon one of these handles causes the portion J′ to curve downward, as shown
> 1691 in Fig. 10, and thus catch the air, *increasing the resistance upon that side of the apparatus* and causing it to turn in that direction." (Italics mine.)

In other words, what would happen would be that the wing whose tip had the greatest angle of incidence would be retarded, while the unretarded wing would climb or rise higher and the machine would wheel, "banking" at the same time, and to straighten out again and restore equilibrium the depressed wing tip would have to be restored and the opposite wing depressed, thus reversing the action, rectifying the equilibrium and to some extent
1692 the course. It is evident that the Messrs. Wright were not in all respects careful students of the art, for according to the record they started in 1900 with the idea that increasing the angle of incidence of one wing would cause that side to rise, whereas, as I have already shown, Huffaker in the Aeronautical Annual of 1897, and Mouillard as just noted (both authorities said to have been studied by the Wright brothers) had pointed out, long prior to 1900, that increasing the angle of inci-

dence of one wing caused that wing to be retarded 1693
and fall.

Thus the Mouillard machine is both steered and balanced by the flexible wing tips, but, like a bird, could only reach a given destination by a process of soaring in circles or curves. In other words, according to the art and according to the Wright patent in suit, if a soaring machine tends to lose its equilibrium by a falling of the right wing, increasing the angle of inclination of the opposite or left wing will cause the right wing to rise, but it will also cause the machine to circle. It appears, however, that the Messrs. Wright did not feel that
they had acquired sufficient skill to undertake this 1694
curving or soaring form of gliding, and they therefore applied a counterbalancing surface. It is evident that if this surface actually did what it was theoretically supposed to do, namely, exactly counterbalance the retarding effect due to the wing warping, the equilibrium would be restored without circling, but it is also evident that the machine would be in no sense dirigible, but would only be a straight line glider and would not at all compare in dirigibility with the Mouillard machine. It is testified, however, that it is possible to make curving flights with
the device of the patent in suit, and the explana- 1695
tion is simple in view of the testimony of Dr. Zahm, and the logic of the facts as set forth in the Wright patent, namely, that the cooperation between the wing warping means and the vertical compensating rudder can only be correct for one set of conditions and is incorrect for all other conditions. It is obvious, therefore, that for other conditions as to velocity and angle of incidence, the machine must wheel or turn whether the operator desires it or not. This of course is not evidence of dirigibility but rather of the lack of it

1696 and it is easy to see that such unbalanced attempts at simultaneous maintenance of equilibrium and direction might easily prove not merely an inconvenience but disastrous. There is thus a marked difference between the statement made by Mr. Wright that he has flown the machine of the patent in a circle, or part of one, and the statement, which he does not make that he could so turn when and where he desired to. This doubtless also explains the admitted failure of the machine of the patent in suit to solve the problem of equilibrium which, as the 1908 Wright Article points out, was not finally solved until 1905. As
1697 I understand the matter they then devised means of correcting, from time to time, the adjusted relation of the rudder to the warping means so that the large errors which would exist in a permanent adjustment could be rectified from moment to moment, or, if desired, an erroneous adjustment could be purposely brought about momentarily for the purpose of utilizing the steering effect of the twisted wing tips as Mouillard described them. This, however, is not disclosed in the patent in suit and it seems to me that, regarded as disclosures to the art, the Mouillard patent is the most complete of the two, for it not only correctly discloses
1698 the effect of the warping of the wing tips, from which maintenance of equilibrium in circling flight naturally follows, but also gives information as to the proportioning of the structure and emphasizes its essential character, while the Wright patent is entirely silent on the subject. This further is true even if it should be alleged that the Mouillard structure is inoperative, because the same is admittedly true of the structure of the patent in suit so far as solving the problem of lateral equilibrium is concerned and constructing a "practical flyer." As to mere ability to glide, such an alle-

gation would not be true for it must be remem- 1699
bered that Chanute actually did fly successfully
with spring-hinged wings for maintaining fore and
aft equilibrium such as Mouillard shows, and
without any other means of producing lateral equi-
librium, while the record shows that many, if not
the majority, of the gliding flights of the Wright
brothers themselves were made without any means
of controlling lateral equilibrium. Any allegation
therefore, as to impracticability of the Mouillard
machine, can only be a charge that it is not com-
pletely responsive to the will of the operator, and
is not in this sense a "practical flyer," which may
or may not be true, but the same thing is admit- 1700
tedly true of the Wright machine of the patent in
suit.

Recess.

As illustrating a machine completely embodying
the three-rudder or three-torque method of con-
trolling a flying machine I will refer to the Boul-
ton British patent #392 of 1868. It is perhaps
worth digressing at the moment to comment on
the name, "Matthew Piers Watt Boulton," of this
patentee. It will perhaps occur to the mind of the
Court that Matthew Boulton was the prominent 1701
English engineer and iron manufacturer whose
scientific attainments and engineering skill led
him to foresee the importance of James Watt's
invention of the steam engine and to supply the
capital with which Watt was enabled to continue
his work. It may also be remembered that this
Matthew Boulton took Watt into partnership and
that it was in Boulton's works that the first steam
engines were manufactured, and these works be-
came the great engine building works of England.
This association and the fact that the two men

1702 became life-long friends naturally suggests that *Matthew Piers Watt Boulton* was a son or grandson of Matthew Boulton, the friend and assistant of Watt, also, possibly, the successor to the management and ownership of the Boulton Engine Works and I am informed that this is the fact. The Boulton patent does not pretend to set forth the entire construction of aeroplanes, but deals specifically with the problems of light weight power producing means and the maintenance of equilibrium. Indeed, he says that the apparatus described may be applied either to dirigible balloons or to aeroplanes, but he shows only the latter type
1703 of machine. As a steam engineer Boulton would have appreciated the difficulty at that time of constructing a steam motor of ordinary type sufficiently light in weight for the purposes of aerial locomotion, and he proposes, therefore, to overcome the difficulty by making use of the jet method of propulsion, employed, as he instances, in the well known skyrocket, without incurring the inefficient use of power characterizing the latter. He says (page 2, line 4 and page 10, line 9):

> "It would be very advantageous to employ the motive power of aeriform jets for the propulsion of aerial vessels if this could be
> 1704 done without excessive loss of power, as in such a mode of propulsion the weight of engines and heavy moving mechanism is dispensed with; but if the simple issue of the jet, as in a rocket, is used for the purpose the loss of power is excessive.
>
> In order to employ the power more efficiently I adopt the following construction: I cause the jet to issue towards the hinder part of the vessel from an orifice contained in a body so shaped as to offer little resist-

> ance to the passage of air. The hinder part 1705
> of this body near the issue of the jet is
> a solid of revolution hollowed out or of con-
> cave section. The jet issues into a tube or
> passage communicating freely with the air,
> so that the jet causes a current of air to
> flow through it from front to stern."

The scientific correctness of this statement is
noteworthy and it at once stamps the patentee as
a scientifically informed engineer, for it will be
remembered that jet propulsion has been many
times applied to boats of various kinds, including
torpedo boats, but particularly to life boats where
there would be danger of a moving screw-propeller 1706
becoming entangled in wreckage or injured in
landing on a rough beach. This experience has
demonstrated that a jet merely forced out against
the water is very inefficient and the jet method
remains inefficient, no matter how applied, until
advantage is taken of the relative kinetic energy
represented by the motion of the water past the
boat. When, however, it is so applied that a cur-
rent enters and passes through from front to stern
and is merely accelerated by the application of the
steam or gas power, then a great increase of effi-
ciency is produced. It will be recognized that a
screw-propeller is merely a means of doing this 1707
very thing and the jet system of propulsion is
merely another way of utilizing the same principle.

Boulton recognized that engines as then constructed were too heavy but that if the power of the steam or gas could be utilized to cause "a current of air to flow through it from front to stern" and merely accelerate the velocity, the reaction occasioned by accelerating the flow would produce a forward effort with relatively large efficiency and light weight of apparatus. This is the Boulton invention so far as it relates to means of

1708 propulsion and I will not discuss it further since the Wright patent in suit has nothing to do with dynamic propulsion but relates purely to the control of a gliding machine. I have referred to it only as illustrating and emphasizing the evident character and attainments of the patentee.

It will be remembered that prior to the Boulton
patent Henson had disclosed his remarkable in-
ventions in the way of aeroplane construction and
control, and that just prior to the date of the Boul-
ton patent Wenham had disclosed his invention
of the multiple machine and his experiments in
their construction and use; LeBris had made his
1709 remarkable flights in a gliding machine, the last
of which had nearly cost him his life because he
could not maintain longitudinal equilibrium; and
Stringfellow had achieved remarkable success with
small flying machines driven by a very small steam
engine. Having all this in mind, doubtless, Boul-
ton says (page 3, line 33, and page 11, line 35):

> "Apparatus as above described may be
> employed to propel aerial vessels supported
> by balloons or vessels containing light or
> heated gases. It may also be employed *to*
> *propel an inclined plane or surface,* by the
> motion of which through the air upward
> 1710 pressure is produced and *the vessel support-*
> *ed in the manner which is well understood*
> *and has often been described.*" (Italics
> mine.)

Boulton proposed to control the equilibrium and dirigibility of such machine by a horizontal rudder or rudders, a vertical rudder or rudders, and a pair of ailerons at the sides, in addition, if desired, to the use of a dihedral angle, but efficient without it. As illustrative of the sort of machine which Boulton might and may have had in mind and to make more vivid the state of the art, I show below an illustration of the prior Stringfellow machine which I take from page 113, Fig. 51 of the Chanute work entitled "Progress in Flying Machines." 1711

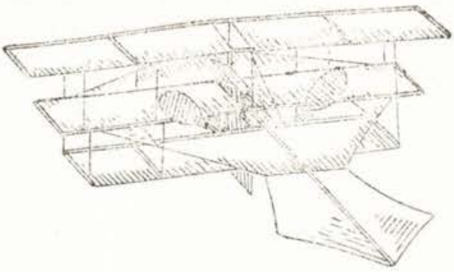


FIG. 51.—STRINGFELLOW—1868. 1712

With such a machine Boulton proposed to incorporate ailerons, such as are used by Curtiss, and vertical and horizontal rudders, and the completeness with which he comprehended the problem is well shown by the following quotation which I have taken from page 8, line 8:

> "For the safety of aerial vessels it is important to provide a controlling power, not only to direct their *horizontal* and *vertical* course, *but also to prevent their turning over by rotating on the longitudinal axis.* A certain stability of the kind 1713
> desired is afforded by using an extended surface whose sides make an angle from the axis upwards as has previously been described by others. But *it is desirable to provide a more powerful action preventing rotation of the body in this direction. For this purpose a rudder of the following construction may be adopted.* Vanes or movable surfaces are attached to arms projecting from the vessel laterally or at

1714 right angles to its length. When these vanes are not required to act they present their edges to the front, so as to offer little resistance to the vessel's movement, but *if the vessel should begin to rotate on the longitudinal axis the vanes are moved so as to take inclined positions, those on the ascending side of the vessel being caused to rotate to such an inclination that the air impinging upon them exerts a pressure downwards, while those on the descending side are so inclined that the air impinging upon them exerts a*
1715 *pressure upwards; thus the balance of the vessel is redressed and its further rotation prevented.* The vanes may be moved by hand or by self-acting mechanism." (Italics mine.)

The operativeness of such a lateral balance "rudder" is, it seems to me, manifest. Indeed perhaps it is one of the few things about an aeroplane that may be said to be *a priori* evident. It is not necessary, however, in this case to rely upon deductions, for the operativeness is made manifest by the Curtiss machine itself in every flight, for Curtiss relies exclusively and
1716 solely upon such rudders (or in the French, "ailerons") for maintaining lateral equilibrium, as the record shows, and further the record also shows the operativeness of ailerons constructed in detail as shown in the Boulton patent. In other words, in substance there is no difference between the ailerons of the Curtiss machine and those of the Boulton patent. Curtiss merely chooses to pivot at the edge instead of near the middle as Boulton shows, but the record shows

that the Boulton ailerons pivoted near the middle 1717
and attached to the wing tips as literally shown and described in the Boulton patent, and the Curtiss-Boulton ailerons pivoted at one edge and located between the planes, are equally effective in producing lateral equilibrium and neither produces any appreciable disturbance in the direction of motion.

Boulton says that the lateral rudders or ailerons may be moved by hand or by self-acting mechanism. He shows them operated by rope so wound around drums attached to their axes as to cause them to turn in opposite directions
as shown by Figs. 6 and 7, these ropes being at- 1718
tached to a weight intended to automatically control their position. In Fig. 5, A represents a cross-section of an aeroplane taken through the axial line of the two vanes constituting the rudder or ailerons. Thus Boulton does not attempt to show the construction of the aeroplane as a whole, but merely shows the cross-section of one plane, which is of course a straight line. Curtiss, however, in using them applies them to a Chanute machine which, it will be seen, is not essentially different from that represented above as due to Stringfellow and which
Boulton may well have had in mind. Referring 1719
to Fig. 5, Boulton says (page 19, line 22):

> "Fig. 5 represents a transverse section of a plane fitted with rudders constructed according to my invention to prevent its turning over on an axis in its line of motion through the air. *a* is a section of the plane which is supposed to have taken a position inclined to the horizon; *b* and *c* are two vanes mounted on axes one at each side of the plane, so that it

> 1720 can be turned round like a throttle valve; *d* is a heavy body suspended by an endless cord, which passing over guide pulleys is wound for several times on barrels on the axes of b and c. When the plane takes an inclined position, as represented in the figure, the weight *d* tending to hang vertically under the center of gravity tightens the cord on one side, slackens it on the other, and thus causes the vanes *b* and *c* to turn into inclined position upon their respective axes. The cord is so wound upon the barrels *b* and *c* that while
> 1721 the one is caused by the action of *b* to rotate in the one direction the other rotates in the opposite direction.
>
> Fig. 6 represents an end view of *b* and Fig. 7 an end view of *c* when these vanes are turned to suit the oblique position of *a* in Fig. 5. The plane being moved through the air in the direction of the arrow *e* the air presses upon the under surface of the vane *c* and on the upper surface of *b* and thus tends to restore the plane to its horizontal attitude."

1722 For maintaining the equilibrium about the other two axes similar rudders or vanes are described. For instance the patent says (page 9, line 1):

> "Vanes acted on by self-acting mechanism of a kind similar to that above described may also be used when desired for keeping the vessel in a fixed course, both vertically and horizontally."

This patent of course, designates vertical and horizontal rudders located in front or behind or both. The Maxim patent, it will be remembered,

shows horizontal rudders for controlling direction 1723
up and down both in front and behind an aeroplane machine, and the modern Curtiss machines employ two such rudders. It will also be remembered that the Wright French patent in evidence issued to the patentees of the patent in suit shows two vertical rudders one in front and one behind for controlling the direction of the machine to the right or left.

Thus Boulton completely discloses a three-rudder control system for aeroplanes, the practicability of which is not only evident of itself but fully proved by the flights made by Curtiss with this
construction. In my opinion the plan is wholly 1724
different from that set forth in the Wright patent, but manifestly at any rate it is identically the plan which Curtiss uses, and if the Wright patent in suit can include the Curtiss machine, it must for the same reasons include the Boulton machine. It will be remembered that Claims 3, 7, 14 and 15 in suit are not limited to any other details of construction or features of construction of the aeroplane, except that Claim 3 is limited to flat planes and the remaining claims are limited to the coordinated operation of the warping wings and vertical rudder, neither of which the defendant's
machine has, and hence the Wright claims in issue are 1725
not differentiated from the Boulton construction by any feature of construction whatever which is found in the Curtiss machine and not in the Boulton patent. If these claims include the one, they must, of seeming necessity, include the other.

Passing now to the last class of machines remaining to be considered, namely machines of the monoplane type, typified in modern practice by the Bleriot machines, I will refer to the Ader machine as illustrated by Defendant's Exhibits "L'Aeronautique Publication" and "L'Aeronautique Trans-

1726 lation" as well as the several drawings in evidence pertaining thereto.

Ader, it appears, was an inventor of prominence who undertook aerial navigation with an intelligent realization of the requirements and who actually flew in a self-propelled machine, rising from the earth propelled by its own power and skimming along above the surface of the earth in free flight. Ader, however, failed to recognize the predominant importance of personal skill, or acrobatic ability, by virtue of which alone the manipulation of a flying machine is possible. Without previous practice or experience in the control of his ma-
1727 chine he attempted free flight propelled by power. It appears from the account published in the Scientific American for August 27, 1898, that he was not wise in the choice of his weather, for while in his first flight "a squall supervened, and the inventor, afraid of being carried along by it, diminished his velocity." Evidently becoming confused, the inventor forgot to steer and the wheels of the machine touched the ground before the turning movement which had been begun was counteracted by steering and the machine skidded and was wrecked in landing, without, however, in any way injuring the inventor.

1728 Referring to Plate XII of the L'Aeronautique Publication, the Ader machine is seen to consist of a wheeled chassis and fore and aft framework carrying the motive power and a pair of widespreading wings seen more fully in Fig. 1 of Plate XIII. A horizontal tail is provided pivoted on a horizontal pivot as shown in Fig. 2, Plate XIII, and a vertical rudder is also located below the horizontal tail and pivoted to it, as shown in Plate XII. A screw-propeller is arranged at the forward end of the machine and its axis is in line with the aver-

age plane of the wing surface as shown in Fig. 2, 1729
Plate XIV.

As Dr. Zahm has fully discussed the mechanism of the Ader machine, I will not dwell upon it in detail but will merely note that Ader considers fully and carefully the longitudinal curvature of the wings and develops a spiral curve which, so far as the eye can estimate, is substantially the curve used in present day flying machines. This curve which he calls the "universal curve of flight or sustentation," is shown in Figs. 26 and 27. The wings are provided with an articulated framework and with "tendons" arranged, as most clearly shown in Defendant's Exhibit "Ader Fig. 33A" 1730
(which is an enlargement of Fig. 33 of the L'Aeronautique Publication), so as to produce a warping of the wing tips above and below the normal position or plane thereof, as shown in Defendant's Exhibit "Drawing Ader Wings Warped" (which is a front view identical with Fig. 2, Plate XIV of the publication, save that both of the operating levers L of Fig. 33 have been moved), thereby simultaneously depressing the rear margin of one tip, increasing its angle of inclination, and similarly decreasing the angle of incidence of the other tip margin, the two levers L, L being worked together
as shown in Fig. 33. 1731

Regarding this construction and its use, the Exhibit Translation, says:

> "Fig. 33 shows in diagram an arrangement of the tendons for working the phalanges of the fingers and of the feet. These tendons are worked by levers, such as L; everything is in perfect equilibrium. During flight the action of the air under the wings meets there its resistance, but if one or the other of the levers is worked separately, as can be seen by noting the course of the tendons, the

1732 equilibrium is destroyed and the resistance to the air changes in location by the fact of the changing of the inclination of the phalanges."

Ader points out that while a machine without this capacity for warping of the wings can be maintained in the air, it can only be done under specially favorable conditions. He says:

"To simplify a wing of the bat-kind one could do away with all or part of the elasticity of the membrane and also paralyze the movements of certain limbs, keeping only
1733 the fixed universal curve and the horizontal pivoting of the wings at the shoulder, which are indispensable. However, with such a wing one can indeed maintain himself in the air, but only under favorable atmospheric conditions."

In his summary he states in enumerating the essential principles and means employed:

"SUMMARY

Thus, as regards the wings of the aeroplane the essential principles and means used by
1734 us are notably the universal curve of sustentation applied to the wings and to their independent propeller. * * * Turning movement of the forearm around the elbow or any part of the wing, to warp it.

Vertical movement of the phalanges of the fingers, for the bat-like wings, and gyral movement of the membrane-bearing ribs for the bird-like wings so as to vary at will, during flight, the degree of curvature of the universal curve of sustentation under the wings." 1735

* * * * * * *

"Rear-wheel steered with the vertical rudder for landing purposes."

It will be noted that operating the warping tendons as shown in Defendant's Exhibit "Ader Fig. 33 A," the warping effected is a compound twisting which, having reference to the right wing, increases the angle of incidence of the tip and decreases it towards the body, while the reverse is accomplished with respect to the left wing. In connection with Fig. 30 of the publication another movement is described which warps the two wings 1736
oppositely as a whole, thus either might be employed, but by warping the wings as shown in Fig. 33 and also in Defendant's Exhibits "Drawing Ader Wings Warped" and "Ader Fig. 33 A," the angle of incidence of the wings is altered without sensibly altering the head resistance, thus giving control of the lateral equilibrium, and this, as the article points out and as noted above, is necessary unless flight is to be limited to very special conditions.

Thus it appears that the warping of the wings in an aeroplane for the purposes of maintaining equilibrium was not new with the Wright Brothers 1737
but had long before been fully described and illustrated in a publication addressed specifically to those skilled in that art which the Wright patent in suit recognizes. Ader did not construct his wings in one continuous plane, but as in the Bleriot machine of the present time, had them constructed as two separate wings one on each side of the main framework. These could be warped separately or together and could be given therefore that peculiar compound or double helicoidal warping referred to

1738 by Huffaker in his article on "The Way of an Eagle
in the Air," but in such a manner as to substantially preserve the head resistance.

Thus it will be seen that the sole novelty of the construction of the patent in suit lies in the specific thing described, namely, the construction of integral planes and the warping of them from tip to tip. This, however, produced extreme differences of head resistance and was entirely ineffective for the purpose and hence such a machine must, to have the warping of any use for balancing be provided with a vertical compensating surface arranged to always turn to counterbalance the re-
1739 sistance by swinging to the side of least angle of
incidence whenever the wings are warped.

It may be objected that in the Ader machine the radius of action of the part whose inclination is increased on the sides where the angle of incidence of the wing tips is decreased, is less than that of the wing tips on the opposite side. The same, however, is true of the rudder of the Wright machine. Admittedly the Wright machine of the patent in suit is not a practical flying machine and does not completely solve the problem of equilibrium. This we know on the authority of the Messrs. Wright themselves. The Ader ma-
1740 chine actually flew and has most complete wing-
warping mechanism. In fact it has every possible movement required for equilibrium. It, however, makes no difference whether it completely solves the problem of equilibrium or not inasmuch as we know that, even supposing that it fails to do so, the same is true of the machine of the patent in suit.

The Bleriot machine of the present day is strikingly like the Ader machine. It is simplified somewhat, to be sure, but Ader points out that his machine may be simplified in various ways. No doubt the Bleriot machine also contains the results of much modern knowledge and investi-

gation, but this was not derived from the Wright 1741
patent. Ader at least not only described the vertical rudder and the wing-warping mechanism but laid the strongest possible emphasis on the importance of wing curvature. I quote fragments only of what he says, as follows:

> "I had tried all kinds of birds' wings, bats' wings and insects' wings, disposed as flapping wings or as fixed wings in conjunction with a propellor, and I had designed motors for each case.
>
> Only then was I able to fathom the depth of all the difficulties to overcome, and
> to perceive the fearful distance which 1742
> separates the original conception from the ultimate realization of the problem. Completing experimentally my first theory on flat and curved surface in movement, through the air and the resistances that they meet, I discovered the important universal curve of flight or sustentation. I finished the study of the flight of the large birds in their habitats, that of the storks at Strasburg, that of the vultures in Algeria, at Constantine. I had some Indian
> vampires fly in my laboratory and sought 1743
> from anatomy the constructive secret of the frameworks of flying animal."

With true prophetic insight Ader says:

> "The future winged machines for the realization of aerial navigation will not flap their wings; to fly they will constantly soar. Their concave wings will support them and a propellor placed in front of them will guide them forward and keep up their speed."

1744 Further emphasizing the curvature of the wings he says:

> "Whatever may be the class of wings, they are essentially curved from front to back in relation to the direction of translation—according to a special curve which is found to be a spiral (Figs. 26 and 27). * * *
>
> This curvature is indispensable to a moving surface to enable it to obtain the maximum support in the air."

Certainly this is in marked contrast to the pat-
1745 ent in suit which, notwithstanding the fact that the record shows that the Wright brothers themselves constructed every machine which they ever made with curved wings, shows merely flat plane surfaces except as they may be bagged by the wind, which, as I understand the matter, is worse than nothing.

In giving this testimony I am bearing in mind the fact that it is the Wright *patent* we are dealing with, and not the subsequent accomplishments of the Wright brothers, because as I understand the matter it is the patent which is, for the purposes of this case, to be taken as the measure
1746 of their accomplishment. Whatever the Wright brothers may themselves have contributed to the art, their patent which is in suit is greatly inferior in its disclosure to this and other references to which I have referred and apparently contributed nothing of value to the art in itself. Had it not been for the fact that a truly light weight motor was developed during the time the Wright brothers were experimenting and that they realized the predominant importance of personal manipulative skill, it is certain that their

patent in suit would never have entitled them to 1747
distinction in the art.

Comparing Claim 3 with the structure of the Ader patent, it is evident at once that Ader does not have a normally flat aeroplane, but has a plane with a definite curvature fore and aft as do all practical flying machines. If, however, the language of Claim 3 can apply to the Curtiss machine which has curved wing surfaces, as taught by Ader and others, then of course it must also include the curved wings of Ader. Claim 3 further recites "lateral marginal portions capable of movement to different positions above or below
the normal plane of the body of the aeroplane." 1748
This is also true of the Ader machine. The claim further specifies "such movement being about an axis transverse to the line of flight whereby said lateral marginal portions may be moved to different angles relatively to the normal plane of the body of the aeroplane and also to different angles relatively to each other, so as to present to the atmosphere different angles of incidence, and means for simultaneously imparting such movement to said lateral marginal portions." All of this applies specifically and exactly to the Ader structure.

Claim 3 therefore presents nothing of novelty 1749
over the Ader construction, unless it is to be limited to the specific warping of the integral main planes from tip to tip, which the patent shows, or to truly flat planes.

I desire to call particular attention to this because it is important to note that the difference between the Wright machine and the Ader machine is merely one of specific means of warping wing surfaces and the different results which follow therefrom. Fundamentally they are alike in that

1750 neither of the two employs auxiliary or rudder-like surfaces for affecting lateral torque. This distinction between the Ader machine and those of his predecessors who like Harte, Boulton, Maxim, Penaud and others used auxiliary surfaces is referred to by the editor of L'Aeronautique in the introduction to Ader's description, as follows:

> "The characteristic which differentiates the Ader aeroplane most from the earlier aeroplanes, of Penaud or Maxim, for instance, consists in the fact that Ader seeks to obtain, principally by the aid of varia-
> 1751 tions in the shapes and position of his *sustaining surfaces* properly so called, the results which the majority of other experimenters seek especially in the action of distinct *auxiliary surfaces*, automatic or not automatic." (Italics in the original.)

The editor here emphasizes the distinction between control by operating the *sustaining surfaces*, and control by operating purely *auxiliary surfaces*.

The Court will see at once that the Wright machine of the patent in suit is in this Ader class of machines which warp their sustaining surfaces, while the Curtiss machine is in the prior class
1752 (Boulton) recognized by the editor of L'Aeronuatique, which does not warp its sustaining surfaces but uses purely auxiliary surfaces.

It appears that Ader's machine actually flew and that Ader was probably the first man ever to rise from the ground in a dynamic man-carrying flying machine. It appears, however, that as a matter of fact the flight was accidental. A large circular track had been erected and it was the apparent intent to try out the machine fully on this track before venturing into the air. The machine, however, rose from the track faced into the wind

and flew, but an untimely squall frightened the 1753
pilot and caused him to descend and to forget to
rectify his course. Thus when the machine alighted
it skidded and was destroyed. I quote from the
account which the Scientific American gives of
this incident in the issue of August 27, 1898 (page
133, as follows):

> "Gens. Mensier and Grillon, who are well
> versed in such matters, had been requested
> to be present at the experiments in an offi-
> cial capacity. The experiments were put
> off from day to day for nearly a week, on
> account of the wind being too violent. Fi-
> nally, on the 14th of October, taking ad- 1754
> vantage of a calm, M. Ader got into his ma-
> chine and set it running. Mounted upon
> wheels, and with the wings outspread like
> a huge bat, the apparatus first passed over
> the track at a moderate speed, while nu-
> merous sentinels prevented anybody what-
> ever from approaching the field of experi-
> ment.
>
> The speed of the Avion progressively in-
> creased, and M. Ader felt and the spectators
> perceived that the wheels were leaving the
> earth. The apparatus, free for an instant
> from any supporting point, veered slightly 1755
> and directed itself against the wind. But
> at this moment a squall supervened, and the
> inventor, afraid of being carried along by
> it, diminished his velocity. The wheels then
> touched the ground again, but, having a
> fixed direction, and the apparatus having
> taken a position that was oblique with re-
> spect to the direction of its motion, they
> could no longer roll. There was a disaster.
> The extremity of one of the wings came into

1756 contact with the track and was broken; the machine upset, the propellers were shattered, and the motors alone remained intact. M. Ader fortunately, got off safe and sound, but the experiments were, of course, interrupted.

Gen. Mensier addressed to Gen. Billot, then Minister of War, a report in which the recommendation was made that the researches be continued and the experiments be renewed, and in which the opinion was given that results so important ought not to be disregarded."

1757 It appears from this article that the Ader machine referred to had a spread of wings of 48 3/4 feet, a net weight of 558 pounds, a total weight with fuel and aviator of 1100 pounds. It was propelled by twin screws revolving in opposite direction in the mean plane of the wings, each driven by a 20 horsepower engine, and the area of wing surface varied between a half pound and a pound to a square foot, according to the load carried.

As I understand the matter the Bleriot machine of the present day is the successor to the Ader machine and perhaps does not differ from the Ader
1758 machine here described on the whole, more than the Wright machine of today differs from the machine of the Wright patent in suit, and certainly it cannot differ in as essential particulars, for Bleriot has merely simplified, maintaining the Ader wing-warping and the Ader rudders, while the Messrs. Wright, have, according to their own statement, so changed the lateral control means as to change the impractical machine of the patent into a practical machine.

Thus this consideration of the art shows that, surveying this art in comparison with the art of

today, we find the Voisin machine flying with the 1759
vertical keel surfaces of Henson, Lanchester, and Chanute, the Farman machine flying with the ailerons of Harte, the Bleriot machine flying with the warping wings of Ader, the Curtiss machine flying with the auxiliary surfaces or three-rudder control of Boulton, and the Wright machine flying with the aid of an invention (if such it be) made two years later than the application for the patent in suit, and all as the result of the development in the meantime of light motors which the original inventors of the prior art machines did not have, with the exception of Ader, and with the personal
skill and courage taught the world by such men as 1760
Lilienthal, Pilcher, and Chanute.

It is hereby agreed between counsel that, on one day's notice to complainant's counsel, the witness, Willard, may be produced for completion of his cross examination and for his redirect eamination at any time before complainant rests its rebuttal, at Dayton, Ohio, or at any other place where complainant may be taking its testimony.

It is also agreed that the British patent to Harte #1469 of 1870 may be added to
paragraph 11 of the answer *nunc pro tunc.* 1761

Adjourned at 7:10 P. M. to Dec. 12, at 10:30 A. M.

New York, N. Y., Dec. 12, 1911.

Met pursuant to adjournment, at 10:30 A. M.

Present—Counsel as before.

(Witness continues.)

Having thus completed the review of the art so far as it seems necessary to give the Court an intelligent understanding of the knowledge pos-

1762 sessed by a man skilled in the art prior to the application for the Wright patent in suit, I call attention in the patent to the fact that not one of the references which I have called to the attention of the Court was cited by the Patent Office during the prosecution of the Wright application, and that the significance of the references is further increased by the fact that the majority of the inventors were engineers and scientists. The great variety in construction and principle exhibited by flying machines of today clearly illustrate the practical value and operativeness and the ideas of these men.

1763 I understand that for the purposes of this case the construction of defendants' machine is illustrated generally in Complainant's Exhibit "Drawing of Defendants' Machine," and that the drawing may be taken as correct, except that it does not sufficiently or correctly illustrate the curvature of the aeroplanes; nor the engine, propelling means, trussing, etc. The machine is seen to consist of superposed aeroplanes arranged substantially as shown in Figs. 229 to 231, and 234 to 252, both inclusive, of Defendant's Exhibit "Gliding Experiments," and like the Chanute machine of these figures (and unlike the machine of the patent in
1764 suit) the aeroplanes have a strong curvature in the fore-and-aft direction. This curvature is substantially indicated in all of the figures, but I call particular attention to Figs. 234, 241 and 245 to 249, inclusive, of Defendant's Exhibit "Gliding Experiments," as illustrating this point. Like the machine illustrated in this Exhibit "Gliding Experiments" the defendant's machine is also provided with a rearwardly extending tail having a fixed horizontal surface and a vertical surface, the latter, however, being movable in defendant's machine.

Projecting out in front is a framework carrying 1765
at its end a sort of box-kite arrangement constituting a horizontal rudder, pivoted to the framework and arranged to be operated by a tiller rod G connected to the rocking upright post F. The vertical rudder is provided with tiller ropes, H, H′, which lead to and around a steering wheel E, as in boats.

The two aeroplanes are united by vertical posts rigidly attached to both planes (also by trussing wires not shown) and incapable of being warped. In other words, the loose or hinged joints having universal motion required by the Wright structure of the patent in suit and illustrated in Figs. 3, 4
and 5 thereof, are not found in defendant's con- 1766
struction.

Attached to the end posts on the front side of the machine and midway between its planes are located the two vanes or ailerons of the Boulton lateral "rudder," and these vanes are connected together by the rope P and to a controlling shoulder frame, formed like the back of a chair, by the ropes M, M′.

The machine is also provided with a depending framework carrying landing wheels as shown in various of the prior references, but these are not illustrated in the exhibit drawing of defendant's
machine. 1767

It will be observed that the machine derives its capacity for control wholly from three independent sets of rudders. Thus if the operator desires to steer to the right or left, he turns the wheel E, thereby swinging the vertical rudder to the right or left, and this movement neither entails nor necessitates any other movement whatever. If he desires to ascend or descend, he pulls or pushes the upright lever F, while if he desires to incline the machine or change its inclination laterally, he leans to one side or the other, and neither this

1768 motion nor the resulting effect entails or requires the movement of the vertical rudder or any other part whatever, as is fully proven in the record.

Thus both structurally and in mode of operation defendant's machine is wholly different from that of the Wright patent in suit, except as both are like the Chanute machine of Defendant's Exhibit "Gliding Experiments."

I have shown above that the editor of L'Aeronautique, writing in 1893, or ten years before the filing of the Wright application, recognized two essentially distinct classes of aeroplane machine, namely, the class, then for the first time disclosed
1769 in the Ader machine, which obtains its lateral control *by warping the sustaining surfaces* themselves, and the prior class, which always retains its sustaining surfaces of fixed shape and controls the equilibrium *by purely auxiliary surfaces.* As the record shows, and as is evident to any one trained in mechanics, these represent wholly different structures and principles. The one (warping the sustaining surfaces) is the method of nature, as exemplified in birds; the other is the method of man, the mere use of rudders.

Starting from a common point, namely, the Chanute machine, with its demonstrated flying capa-
1770 cities, well known and widely discussed the world over, the Messrs. Wright on the one hand, and Mr. Curtiss on the other, proceeded in opposite directions; the Wright brothers following in the footsteps of Ader and warping the sustaining surfaces, changing the rigid structure by the introduction of flexible universal joints, while Mr. Curtiss merely applied the three-rudder system of the prior Boulton patent, and retained the rigid trussing of Chanute. Certainly, as it seems to me, no two concepts or structures could be more entirely different and preserve at all the common features of the success-

ful prior machines from which both evidently 1771
started, and surely both had the right to start with the demonstrated successful machine of their predecessor, especially as Chanute gave his machine to his fellow countrymen by his failure to patent it.

A detailed comparison of the operations involved in controlling the two machines, and the results thereof, is interesting. In controlling the machine of the patent in suit, the operator lies "belly-bender" fashion on the lower plane, like a child on a sled. With his hands he grasps the windlass 37 while his hips lie between and rest against the upright members of the cradle 18. If he desires to
ascend or descend, he revolves the windlass or roller 1772
in one direction or the other, thereby bending the rear edge of the front rudder up or down, while if he desires to influence the lateral equilibrium, he shifts his hips to one side or the other, carrying his weight in the meantime on his hands and toes while making the motion. This motion warps both of the supporting planes throughout their whole length, twisting one end of each in one direction and the other end of each in the opposite direction. This increases the angle of incidence at one end and decreases it at the other, and every point between the two wing tips undergoes a graded change between these two (except possibly some point at
or near the middle). This primarily changes the 1773
head resistance and would cause the wing having the greatest inclination to be retarded and fall were it not for the fact that the same motion which warps the wings inevitably, by virtue of mechanical interconnection, turns the vertical compensating surface, or so-called rudder, so as to increase the head resistance on the side where the wings have the least inclination, and hence the least head resistance. If the machine is properly proportioned and the rudder connections properly made, this equalizes the head resistance and permits the

1774 wing having the greatest inclination to climb, while retarding the forward motion of the machine as a whole, thereby compelling the operation of the horizontal rudder if a true horizontal course is to be maintained.

Recess.

If he desired to turn to the right or to the left, he is provided with no means for doing so except as his acquaintance with the individual machine may enable him to resort to the trick of taking advantage of the lack of perfect compensation by the vertical surface, and so take advantage of an un-
1775 balanced resistance due to the wing tips having the greater angle of inclination.

In the Curtiss machine, in contrast with all this, the operator sits comfortably in a seat, and by independently operable means controls either one of the three rudders, neither one of which either entails or requires any movement of any other. The contrast is most striking and is not the result of an improvement by Curtiss upon the Wright machine, but of the adoption of an entirely different principle and mode of operation, namely, the use of auxiliary rudder surfaces instead of the warping of the sustaining surfaces.

1776 In comparing the Curtiss machine with Claim 3 of the Wright patent in suit I find at the outset that the Curtiss machine does not have "a normally flat aeroplane," or anything approaching it, or operating in the same way. On the contrary it has strongly curved surfaces following the lead of Henson, Lanchester, Penaud, Lilienthal, Ader, Chanute, and others of the prior art to whom I have referred. Referring to the specification I find that the patentees on page 5 in the paragraph extending from line 51 to 62, define a normally flat surface as one which is substantially flat, except as a surface when constructed of cloth "may receive more or less curvature from the resistance of the air." In other words, when the patentees say "flat," they mean "flat," and they do not mean strongly curved surfaces which, as the prior art shows, have a markedly different action from that of flat surfaces. 1777

Further examining Claim 3 I find that the Curtiss machine does not have any "aeroplane having lateral marginal portions capable of movement to different positions above or below the normal plane of the aeroplane, such movement being about an axis transverse to the line of flight," or any other axis. The Chanute machine has parallel aeroplanes 1778
with strongly curved surfaces rigidly trussed together so that neither the lateral marginal portions nor any other portion could move. Curtiss has taken these rigid parallel planes, preserving all of their rigidity, and has no portions thereof, marginal or otherwise, capable of movement to different positions above or below the normal planes, as recited in Claim 3. The claim further requires that, as a result of the movability of the lateral margins, "said lateral marginal portions may be moved to different angles relatively to the normal plane of the body of the aeroplane and also to different angles relatively to each other so as to pre- 1779
sent to the atmosphere different angles of incidence." The Curtiss machine has no movable portions and is wholly incapable of producing the result here described, or any equivalent result. Further, the Curtiss machine has no "means for simultaneously imparting such movement to said lateral marginal portions, having no such portions and no means of moving any portion simultaneously or otherwise. The Curtiss machine has the lateral rudder of Boulton and Boulton's operating connections, and these are not only not a part of

1780 the aeroplane but, as in the Boulton patent "when these vanes are not required to act they present their edges to the front, so as to offer little resistance to the vessel's movement" and no supporting effect. Also as described by Boulton,

> "if the vessel should begin to rotate on a longitudinal axis the vanes are moved so as to take inclined positions, those on the ascending side of the vessel being caused to rotate to such an inclination that the air impinging upon them exerts a pressure downwards, while those on the descending side are so inclined that the air impinging
> 1781 upon them exerts a pressure upwards; thus the balance of the vessel is redressed and its further rotation prevented,"

without producing any unbalanced head resistance or any turning effect requiring simultaneous coordinated movement of a vertical compensating surface or a rudder. The difference is most striking, for whereas in the Wright structure the effect is a complete twisting or warping of the whole sustaining surface from one end to the other, whereby one end has a more positive angle of incidence than the other, the Boulton rudders em-
1782 ployed by Curtiss are turned so that one has a negative and the other a positive angle of incidence, exerting equal head resistance, but a doubled righting or equilibrating action. It should be noted that the expression "different positions above or below the normal plane of the body of the aeroplane" in Claim 3 does not mean a positive angle of incidence on one side and a negative on the other, but, as the file wrapper clearly shows, means that the positive angle of incidence on one side is made less than the normal, while that on the other side is made greater than the normal, thus the righting or equilibrating effect (when the

rear rudder compensates so that there is any 1783
such effect) is merely the *difference* between
the effect of the two sides, whereas with rudders
such as Curtiss has adopted from the Boulton
patent, this righting effect is the *sum* of the
vertical pressures on the two sides. That the
construction and mode of operation are wholly
different and in no sense equivalent is thus fully
shown, but it is further emphasized by the fact,
shown by the record, that, if the machine of the
patent in suit turns or swerves, it is the result
of the unbalanced wing pressure and the turning
is in the contrary direction to that to which
the rudder is turned, since, according to the 1784
sworn statements of the patentees, the rudder is
in no sense a steering device. On the contrary,
the Boulton rudder or ailerons, which the Curtiss
machine employs exert no steering effect and the
machine steers only by turning the rudder to
the side toward which the machine is to turn,
the vertical rudder being thus purely a steering
device acting like a ship's rudder, and only so.
Further, and even still more removed from the
structure of the patent in suit than is the
structure of the Boulton patent, the Curtiss
machine has its lateral rudder system, or aile-
rons, entirely removed from the supporting planes, 1785
being located, as purely auxiliary surfaces, in
a plane intermediate between the supporting
planes. Still further, while the Boulton vanes
or ailerons have this formal resemblance to the
Wright construction that one edge moves up when
the other moves down because the transverse
pivotal axis approaches toward the center, the
Curtiss vanes or ailerons have not even this
resemblance because they are pivoted at their
front edge and the whole surface of each vane
moves up or the whole surface moves down.

1786 In other words, the Curtiss structure is not only different from that of Claim 3 in every feature referred to in that claim, but it operates on a different principle, in a different way, and with different results, there being manifestly no equivalence of structure, function or mode of operation. Thus whatever similarity the Court may perceive, when looking at the pictures of the two machines, is merely the result of their common origin in the Chanute biplane machine as noted above, while in every respect referred to in the Claim they are different.

Referring now to Claim 7, I quote the claim as
1787 follows, as I have not heretofore done so.

> "7. In a flying machine, the combination, with an aeroplane, and means for simultaneously moving the lateral portions thereof into different angular relations to the normal plane of the body of the aeroplane and to each other, so as to present to the atmosphere different angles of incidence, of a vertical rudder, and means whereby said rudder is caused to present to the wind that side thereof nearest the side of the aeroplane having the smaller
> 1788 angle of incidence and offering the least resistance to the atmosphere, substantially as described."

As the specification itself points out, the combination of Claim 3 just above referred to is inoperative because without the coordinated operation of the rear rudder there is no righting or balancing force exerted. Claim 7 adds to Claim 3 the further elements described as a vertical rudder and means corelating the two, so that whenever the wings are warped to make the angle of incidence greater on one side than on

the other the rudder will turn oppositely, that is, 1789
towards the side having the least angle of incidence. It is this action of the rudder as a compensating device which alone gives the wing-warping any balancing power, and even this does not produce a practical flying machine for, as the patentees have themselves stated in their 1908 article (Defendant's Exhibit Wright Brothers Article in Century Magazine for September, 1908") on pages 649 and 650 thereof, the problem of equilibrium was not solved until September, 1905, more than two years after the application for the patent in suit.

Claim 7 further differs from Claim 3 in that it 1790
omits the words "normally flat" qualifying the word "aeroplane." Regarding this the specification says (p. 5, line 51):

> "We have used the term 'aeroplane' in this specification and *the appended claims* to indicate the supporting-surface or supporting-surfaces by means of which the machine is sustained in the air, and by this term we wish to be understood as including any suitable supporting-surface *which normally is substantially flat,* although, of course, when constructed of
> cloth or other flexible fabric, as we prefer 1791
> to construct them, these surfaces may receive more or less curvature from the resistance of the air, as indicated in Fig. 3." [Italics mine.]

The patentees have here defined the meaning of "aeroplane" in the claims as designating a plane "which normally is substantially flat," saying, however, that such slight bagging as may occur in the wind would not take an otherwise flat plane outside of their description. The prior art set forth, as I have shown, that the

1792 planes should be strongly curved and not in any sense substantially flat, it being pointed out that this was of great practical importance. I take it that the word "substantially" as used in this definition of the word "aeroplane" means as near flat as can conveniently be constructed, and not departing from flatness in any way altering the operation. The prior art shows that curved planes have a fundamentally different operation, and Curtiss in taking the Chanute machine with its normally curved surfaces not only followed the prior art but did the thing which the definition of the patent in suit seems to definitely
1793 exclude from the meaning of the claim. I take it, therfore, that the Curtiss machine does not have the aeroplane of Claim 7.

It further does not have, as pointed out with respect to Claim 3, any movable lateral or other portion of its aeroplanes, or any means for moving such portion. Having fully pointed out these differences and my consideration of Claim 3, I will not repeat.

Further, the Curtiss machine does not have "a vertical rudder" in the sense of the Wright patent in suit. As appears from the statement of Mr. Wilbur Wright in evidence, the so-called
1794 vertical rudder of the Wright patent is one which acts in an entirely different manner from that of a ship's rudder. Further, regarding this the patentees said in prosecuting their case in the Patent Office:

> "As to the vertical rudder, it is *in no sense a steering device*, but is simply for correcting the increased resistance offered by one end of the machine over the other arising from the different angles at which the ends of the planes are presented to

the wind, and this it does *automatically.*" 1795
* * * [Italics mine.]

In other words, the use of the term "rudder" means nothing and the patentees would have escaped difficulties in the Patent Office if they had called it something else. The Curtiss machine has a true ship's rudder, which is in every sense a steering device and in no sense anything else. The Curtiss machine therefore does not have the element of Claim ~~3~~ called a vertical rudder. 7

The Curtiss machine further does not have "means whereby said rudder is caused to present to the wind that side thereof nearest the 1796
side of the aeroplane having the smaller angle of incidence, and offering the least resistance to the atmosphere," and this is true for a great many reasons. The primary feature referred to in the claim is of course the attachment of the so-called rudder ropes to the warping rope "whereby said rudder is caused to present," etc. There is no such means in the Curtiss machine because each of the controlling surfaces of the Curtiss machine is operated by entirely distinct means from any of the others, so that the operation of each control element is absolutely separate and
distinct from the operation of the other, and 1797
since, as I understand, the claim requires means establishing forced corelated operation of the rudder when the wings are warped, this being the central feature of the whole patent, it is seemingly impossible that the Curtiss machine can be within the description of this claim. Further, however, the Curtiss machine has no movable lateral portions, and no side having a smaller angle of incidence, and no side offering the least resistance to the atmosphere, but, on the contrary, so far as is humanly possible the angles and the resistances are alike and the

1798 claim therefore finds no correspondence at all in the Curtiss structure, could not have been based upon it, and has no meaning when read with reference to it. Further, as pointed out in my consideration of Claim 3, there is no equivalent action of any kind, the operation being, in the Curtiss machine, purely that of the Boulton patent of the prior art.

It is evident, it seems to me, that if Claim 7 is divorced from the description and mode of operation set forth in the specification, so as to include the Curtiss structure, by some process of interpretation which does not occur to me,
1799 it must include the structures of the Johnston patent, the Harte patent, the Boulton patent, and the Ader patent which I have discussed in the foregoing parts of my answer.

Not having quoted Claims 14 and 15, I now do so as follows:

> "14. A flying-machine comprising superposed connected aeroplanes, means for moving the opposite lateral portions of said aeroplanes to different angles to the normal planes thereof, a vertical rudder, means for moving said vertical rudder toward
> 1800 that side of the machine presenting the smaller angle of incidence and the least resistance to the atmosphere, and a horizontal rudder provided with means for presenting its upper or under surface to the resistance of the atmosphere, substantially as described."

> 15. A flying-machine comprising superposed connected aeroplanes, means for moving the opposite lateral portions of said

aeroplanes to different angles to the normal 1801
planes thereof, a vertical rudder, means for
moving said vertical rudder toward that
side of the machine presenting the smaller
angle of incidence and the least resistance
to the atmosphere, and a horizontal rudder
provided with means for presenting its
upper or under surface to the resistance
of the atmosphere, said vertical rudder
being located at the rear of the machine
and said horizontal rudder at the front
of the machine, substantially as described."

Claim 15 differes from Claim 14, in terms, only
in the last clause of Claim 15, which contains 1802
the added requirement over Claim 14, that the
vertical rudder shall be located at the rear and the
horizontal rudder at the front. Claim 14 differs
from Claim 7 apparently only in that it recites
and requires a horizontal rudder provided with
means for presenting its upper or under surface
to the resistance of the atmosphere and in being
limited to the Chanute arrangement of superposed
connected aeroplanes.

It will of course be understood that superposed
connected aeroplanes were not new with Chanute
but date from a very early period in the art, hav-
ing also, for example, been made and flown by 1803
Lilienthal. I refer to such planes as the construc-
tion of Chanute because it was Chanute who ap-
parently gave them the most prominence in
their fully trussed rigid form. What Claim 14
calls for in this respect might, therefore, be equally
well stated as follows: A Chanute flying machine
having its superposed connected aeroplanes flexi-
bly instead of rigidly connected, to permit of warp-
ing movement, and means for moving the opposite

1804 lateral portions of said aeroplanes to different angles, etc. As pointed out above, however, this would exceed the description of the Wright patent in that the Chanute aeroplanes had curved surfaces, whereas the patentees have expressly limited themselves to substantially flat surfaces. In using the above expression therefore, I refer merely to the superposed relation and the flexible linkage to permit helicoidal warping.

As noted with respect to Claim 7, the Curtiss machine does not have the Wright aeroplanes, nor any movable lateral portion, or means for moving the opposite lateral portions to different angles,
1805 or a vertical rudder, or means for moving said rudder toward that side of the machine presenting the smaller angle of incidence or the least resistance. On the contrary it is the Chanute machine of the prior art with Chanute's curved surfaces and Chanute's rigid non-warpable trussing. To this Curtiss has added the Boulton vertical rudder (or in general the ordinary vertical rudder universal in the prior art) and the Boulton lateral rudder, and, noting that Claim 14 also refers to a horizontal rudder, the Boulton horizontal rudder. In other words, Curtiss has Boulton's three-rudder control for the same purpose and operating in the
1806 same way, and nothing else.

Having reference to the horizontal rudder required by the claims, 14 and 15, I may note that Curtiss does not depend upon the horizontal front rudder alone. He has in the machine here charged with infringement a front horizontal rudder operating in combination with a rear stationary horizontal rudder or tail. The Wright patent has much to say about the horizontal rudder of the patent. For instance it is a flexible or warpable surface, and great efficiency is ascribed to it on this account.

Further it is a large surface, as shown for instance 1807
in Figs. 1, 2 and 3, and is spread out in a single
surface designed as pointed out in column 1, page 5,
to have a certain automatic action in the event of
a sudden backward travel of the center of pressure
on the aeroplanes which the patentees say is often
productive of serious injury. It will be recognized
at once that a rudder or tail placed behind would
accentuate this difficulty, and, further, that putting
the front vertical rudder in two decks or super-
posed parallel surfaces would have this automatic
stabilizing effect. Curtiss of course has to have a
horizontal rudder for steering purposes and he
would have to put in either in front or behind, but 1808
he has counterbalanced it by fixed tail behind and
thus entirely removed this automatic stabilizing
effect referred to in the Wright patent. He has
adopted the fore-and-aft horizontal rudder scheme,
of Maxim and Boulton, for instance, and has abso-
lutely eliminated both of the features emphasized
as important by the patentees of the patent in suit.

In my study of this case I have set myself the
problem of starting with the Chanute machine and
designing an apparatus which should completely
embody the prior art and be in every respect unlike
the machine of the patent in suit, and I have been
unable to find any way which would be more ut- 1809
terly removed from the machine of the patent,
either as described in the specification or as set
forth in the claims in issue, or which, starting with
the Chanute machine as a basis, could be said to
be more radically different in construction, prin-
ciple and mode of operation than is the Curtiss
machine. I have no personal knowledge as to
whether Mr. Curtiss, in designing his machine
charged with infringement, had any knowledge of
the Wright machine of the patent or not, but if

1810 he had had that patent before him and the prior art also before him and had made the most conscientious effort to construct a prior art machine pure and simple and avoid in any and every way even the semblance of copying of the Wright structure, he could not have used the Chanute machine, which he had a right to, and the prior art, which he had a right to, in any way which would have been so totally unlike the machine of the patent in suit.

I have called attention to the fact that the Boulton patent does not pretend to set forth the details of construction of an aeroplane. It deals,
1811 so far as it is of importance in this case, solely with the three-rudder system of control and primarily and specifically with lateral balance by means of lateral vanes constituting, as he calls it, a lateral "rudder." He says take any approved aeroplane structure and apply to it the three-rudder system of control. This is exactly what Curtiss has done. He has taken the Chanute machine with its rigidly trussed surfaces and its fixed horizontal tail and has added thereto, in accordance with Boulton's instructions, the three-rudder control means described by Boulton, and so far as concerns the matters involved in this case he has
1812 done absolutely nothing more. On the other hand, he has, as noted above, avoided doing anything set forth in the patent in suit.

For the foregoing reasons the defendant's machine does not contain the combinations which I understand are recited in Claims 3, 7, 14 or 15 of the Wright patent 821,393 in suit, but if by any process of interpretation these claims can be construed as including the Curtiss machine complained of, then, so far as I am able to judge, those claims must also include the prior art structures and particularly the Boulton structure, of Boulton

British patent No. 392 of 1868, which Curtiss has 1813
adopted and which is exemplified in the defendant's machine.

> Counsel for defendants herewith introduces a certified copy of the Lanchester British patent No. 3608 of 1897, and of the Maxim British patent 19228 of 1891, and requests that they be marked as Defendants' Exhibits "Lanchester Patent" and "Maxim Patent 19228," respectively.

Q6. Will you please state a little more specifically whether or not, in your opinion, defendants'
machine contains that portion of Claims 14 and 15 1814
which reads,

> "superposed connected aeroplanes, means for moving the opposite lateral portions of said aeroplanes to different angles to the normal planes thereof"?

A. In my opinion it does not. As noted in my last answer the patentees have taken the Chanute machine which had parallel aeroplanes rigidly trussed, and provided the connecting upright members with universal joint connections whereby the peculiar elongation of one diagonal axis and short-
ening of the other, which characterizes the Wright 1815
structure, becomes possible. Claims 14 and 15 require, in accordance with this construction, that the lateral *portions* of *both* of said aeroplanes shall be warped as set forth in the claims. The Curtiss machine, on the other hand, preserves the rigid parallel-plane trussing of the Chanute machine and does not move either of the planes, and hence does not move both of them as the claims require. Further, it does not move a plurality of control surfaces on each side. It has merely the Boulton vanes, but unlike Boulton these are com-

1816 pletely disassociated from either of the supporting planes. Whereas Claims 14 and 15 require the motion of a plurality of portions of the supporting surfaces at each side, the Curtiss machine moves only a single surface and that not a part of either of the planes, nor a part performing the functions of the moving parts referred to in the claims, either singly or in duplicate. In other words, as I understand Claims 14 and 15 their description would not be met if Mr. Curtiss had built the actual machine of the Wright patent, except that he warped only one surface, since as the claims are worded they require the warping of both surfaces. In
1817 point of fact, however, Mr. Curtiss does not warp either of the surfaces which the claim requires to be warped, nor any surface whatever.

Q7. Will you please state whether or not you have found more definitely who Mr. Boulton, the patentee of the Boulton patent, was?

A. I have caused a search to be made in the biographical literature dealing with engineers, and the searcher reports to me that he finds therein a reference to the London Times for July 4, 1894, which contains the following statements:

> "Matthew Piers Watt Boulton of Great Tew, Oxfordshire, who died Saturday, June
> 1818 30, 1894, at the age of 74, was the grandson and only surviving male representative in his generation of the once famous partner of Watt, at whose works in Soho near Birmingham, the steam-engine was brought into existence. He was a most gifted member of a gifted family, and the inheritor of a large fortune, and highly cultured; but being naturally a recluse, with no care for self-assertion, his wide knowledge and sterling qualities were known only to a few. He was educated at Eton, and at Trinity

College, Cambridge, where he won a University prize in spite of his refusal to engage seriously in scholastic competition." 1819

The biography thus shows that Boulton, the patentee, was the grandson of the same Matthew Boulton who, as I have said in my preceding deposition, was the associate of Watt and the man to whose faith and foresight was due the development of the steam engine, which Watt had devised but was financially unable to carry out. It seems also that this establishment of Watt and Boulton became the largest and best known of its kind in England, and was celebrated the world over for the
excellence of its product and the superior skill of 1820
its workmen. This was the heritage then to which Boulton, the patentee, to whom I have referred, succeeded.

FRANK N. WATERMAN.

By Mr. Toulmin: I understand that the direct examination of this witness is now closed at 4:35 P. M., December 12th, 1911. I protest against the manner in which the deposition has been taken because the same had the effect of depriving complainant of the right to cross examine without extending
the time which the Court has fixed for the 1821
closing of the evidence of defendants. The order of the Court made on the 14th of November, 1911, limited defendants' time to Dec. 12th, 1911. This witness has been testifying in direct since the 27th of November, 1911. The record shows that the time of convening the sessions day after day has been 11 A. M., with a possible exception or two. It also shows that, with the exception of once or twice, the sessions have been closed at 4:30 P. M. Much of the time

1822 when the witness could have been testifying has therefore been wasted. Again, the last preceding witness finished his deposition on the 17th of November, 1911, thus showing the lapse of ten days between that day and the commencement of the deposition of this witness. Under these circumstances, and seeing that at this late hour and promptly at the end of the time limited by the Court, I cannot cross examine this witness without extending defendants' time, which I decline to do. Notice is therefore given of the following:

1823 1. That on or before the hearing of this cause complainant will move the Court to disregard or suppress this deposition for the reasons appearing in the above statement;

2. Objection is made to practically the entire deposition on the ground that it is neither an opinion nor a statement of facts within the knowledge of the witness, but a mere argument based upon hearsay, and as such incompetent;

3. Objection is also made to all that part of the deposition which discusses the prior
1824 publications because the deposition constitutes new matter not found in such publications themselves.

By Mr. Newell: I regret that the testimony of the witness was not completed before this time. We expected and tried to finish it last week but were unable to do so. As to the sessions, the usual time of an expert's deposition, so far as my experience goes, in this City is from 11 A. M. to 4 P. M., with one hour for lunch. I think we have

exceeded this every session. Mr. Waterman 1825
had to go into this case from the beginning,
read practically all of the testimony, which
is very voluminous and become familiar with
the multitudinous details of the case before
he could even start his testimony.

Counsel does not desire to cut short in
any way complainant's right of cross examination
and instructs him that the witness
is now ready for cross examination and that
he may proceed with him without any regard
to the time limited by the Court, if he
wishes, for defendants' counsel desires complainant
to cross examine fully and for as 1826
many reasonable days hereafter as he may
wish.

By Mr. Toulmin: For the reasons already stated I decline to be drawn into a plan which will have the effect of extending defendants' time for closing its deposition beyond that which the Court has set, which was ample under the last order and was all that defendants asked for, namely, four weeks. The tender of the witness under these circumstances is of no consequence and a mere form and is declined.

By Mr. Newell: You then do not care to 1827
cross examine the witness?

By Mr. Toulmin: Yes, I have desired to exercise my right and my complaint is that I have been deprived of it by the manner in which this deposition has been taken.

By Mr. Newell: Very well. As it is now 5 P. M. we will adjourn and the witness will be presented for cross examination to-morrow morning. If you do not appear to cross

1828 examine at that time, I shall understand that you do not desire to.

By Mr. Toulmin: The time to close this deposition is now and if it stands open, unclosed, or unsigned, after to-day, the same shall constitute an additional reason for moving the Court to disregard it or suppress it.

By Mr. Newell: The direct examination is closed and unless you state that you will now go on for cross examination or will go on to-morrow, the witness will sign his deposition and be allowed to go. If you wish
1829 to go on to-morrow, the witness will be presented for such purpose. I should like to know whether you will go on now or to-morrow, or not at all?

By Mr. Toulmin: As the witness has been testifying, since, or started on, November 27th, 1911, it is perfectly obvious that the required cross examination will occupy a number of days, possibly a week, possibly more. At any rate between now and midnight when it may be said defendants' time expires, the cross examination cannot be con-
1830 ducted. As I decline to be a party to any extension of the time, I therefore repeat that the tender of the witness at this late hour is regarded as illegal and ineffective. The deposition in its incomplete form I am not willing to cure by being a party to extending the time limit set by the Court.

By Mr. Newell: The witness is requested to sign his deposition at the end of his direct examination.

By the Notary: The witness does so.

By Mr. Newell: Defendant rests, except that the witness will be produced to-morrow morning at 11 A. M. in case you change your mind over night and decide to go on for cross examination. If not, defendant's case is closed so far as advised at present. 1831

By Mr. Toulmin: I do not recognize that this deposition or the defendant's right to continue the same extends into to-morrow or beyond the time set by the order of the Court, and I now object to any notation on the record to-morrow.

Adjourned to Dec. 13, at 11 A. M.

New York, N. Y. December 13, 1911. 1832

Met pursuant to adjournment, at 11 A. M.

Present—Mr. Newell for Defendants;

No one appearing for Complainant.

The witness is also present and ready for cross examination.

4.30 P. M. No one having appeared in behalf of complainant, defendant's testimony is closed.

Magistrate's Certificate.

UNITED STATES DISTRICT COURT,

Western District of New York. 1833

The Wright Company

vs.

The Herring-Curtiss Co. and Glenn H. Curtiss.

In Equity No. 400.

I, Beatrice Mirvis, a notary public in and for the County of New York, do hereby certify that pursuant to notice issued and served in the above-

1834 mentioned cause, I was attended at the office of Emerson R. Newell, #2 Rector Street, New York City, N. Y., by said Emerson R. Newell, of counsel for defendants, and also by H. A. Toulmin, of counsel for complainant, on the several days and dates stated in said testimony; that the witnesses named therein, viz., Augustus Post, Wilbur Wright, Theodore G. Ellyson, Paul W. Beck, Charles F. Willard, George Kibbe Turner, Glenn H. Curtiss, Albert F. Zahm, Albert Stetson, George A. Spratt and Frank N. Waterman who were of sound mind and lawful age, were by me first carefully examined and cautioned and duly
1835 sworn to testify the truth, the whole truth and nothing but the truth, and they thereupon testified as is above shown, and that the depositions by them subscribed as above set forth were by me reduced to writing in the presence of the witnesses themselves and from their statements, and were then subscribed by the said witnesses in my presence and were taken at the places indicated and at the times set forth, adjournments being had or taken from day to day as indicated; and that all was so done, written and signed in the presence of said counsel for complainant and defendant. I further certify that the reason for taking said depositions
1836 was and is, and the fact was and is, that all of the deponents live more than 100 miles from the place where said Court was sitting and said suit is appointed by law to be tried, and that the witness Curtiss was also about to go out of the district in which the case is to be tried and to a greater distance than 100 miles from the place of trial before the time of trial, viz., to California, and that he did so go to California and is there at the present time; that I am neither of counsel nor attorney to either of the parties to said suit, nor

interested in the event of said cause; and that it being impracticable for me to deliver said depositions with my own hand into the Court for which they were taken, I have retained the same for the purpose of being sealed up and directed with my own hand and speedily and safely transmitted to the said Court for which it was taken, and to remain under my seal until then opened. That portion of the cross examination and the redirect examination of the witness Willard included in typewritten pages 229-1 to 229-24 was, by agreement between counsel, taken on March 15, 1912 at Dayton, Ohio. I further certify that my fees for taking said testimony amounting to $343.50 have been paid by defendant. 1837 1838

Witness my hand and seal at New York City, New York, County of New York, this 21st day of March, 1912.

BEATRICE MIRVIS,
[SEAL.] Notary Public, #160,
N. Y. Co.

[766]

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